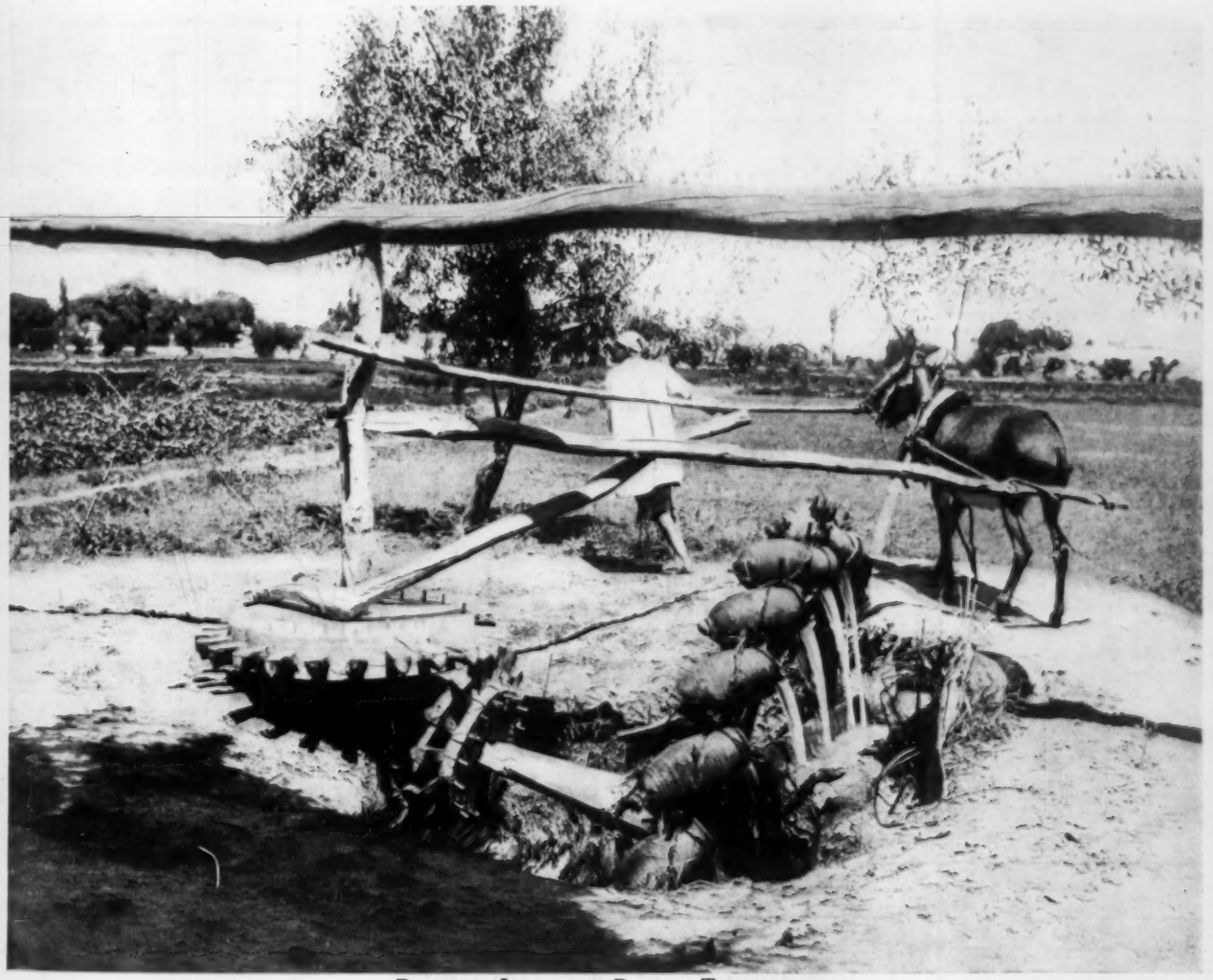
Engineering
Library

JAN 7 1932

CIVIL ENGINEERING

Published by the
American Society of Civil Engineers

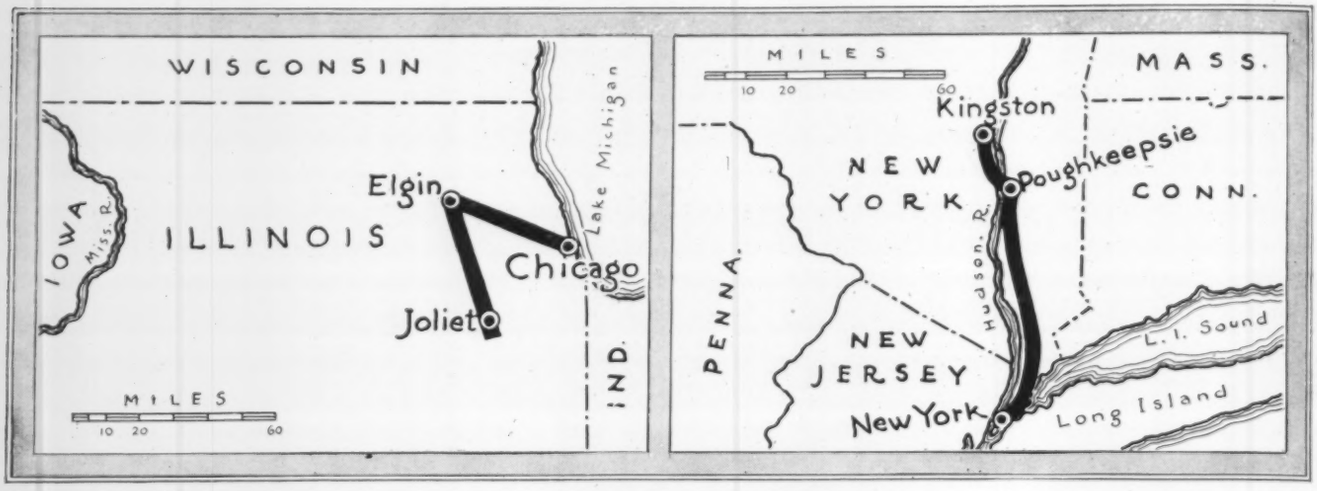


PRIMITIVE IRRIGATION PUMP IN TURKESTAN
These "Chigirs" Raise Water from Ditch to Field

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Volume 2 — Number 1 —

JANUARY 1932



MacArthur is driving 73 Miles of Piles to uphold the Cincinnati Union Passenger Station . . . . . .

On April 22nd we received the 6,595 pile contract for the Union Passenger Station. This made the sixteenth contract which had been awarded to us for the Cincinnati Union Terminal Development since January, 1930.

Laid end to end the 6,595 piles in the one contract for the Union Passenger Station would reach more than seventy-three miles, and we've indicated this approximate distance on the sectional maps on this page.

No contract is too large nor too small to get the service which has built our reputation for speed and dependability, and it may be mutually advantageous for you to discuss your next pile contract with us.

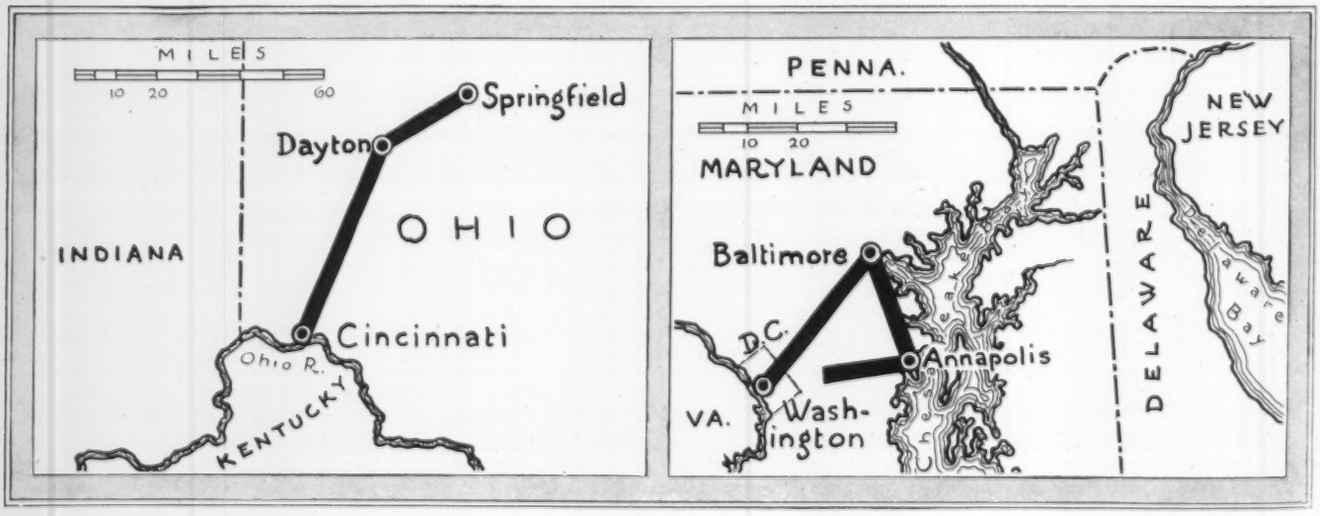
Check your requirements against MacArthur qualifications:

Product	*proven*
Experience	*21 years*
Equipment	*latest*
Resources	*unlimited*
Personnel	*capable*
Clientele	*illustrious*
Responsibility	*demonstrated*
Engineering	*sound*
Performance	*100%*
Speed	*record-breaking*

MacARTHUR
CONCRETE PILE CORPORATION
19 WEST 44th STREET, NEW YORK, N. Y.

Branch offices
CHICAGO NEW ORLEANS PITTSBURGH CLEVELAND BOSTON DETROIT
PHILADELPHIA SOUTH JACKSONVILLE, FLA. BUFFALO WASHINGTON, D. C.
CANADIAN MacARTHUR CONCRETE PILE CO., Ltd., MONTREAL

Giles Drilling Corporation (an affiliated company) will welcome the opportunity to submit estimates on core borings or soundings of any description.



Among Our Writers

P. Davis entered Government service in 1884. As a topographer for the Geological Survey he made exploration surveys for irrigation works. As Chief Engineer of the U.S. Reclamation Service, and later as its Director, he carried out a great many of these irrigation enterprises. As Chief Engineer and General Manager of the East Bay Municipal Utility District, Oakland, Calif., he built an aqueduct and a large storage dam to supply nine cities on the east shore of San Francisco Bay.

Noel J. Ogilvie entered the Canadian Government Survey in 1901 as a member of the International Boundary Survey and for many years was engaged on boundary work in southern British Columbia and southeastern Alaska. In 1917 he became director of the Geodetic Survey of Canada and in 1931 was appointed His Britannic Majesty's International Boundary Commissioner.

A. V. Karpov, who was born in Russia, received an engineering education in Russia and Germany. He practiced in Europe until 1920, when he moved to the United States and became a citizen. He has specialized in hydraulic construction, hydraulic laboratory practice, and hydro-electric developments.

R. L. Templin is a research specialist. After graduation from the University of Kansas he entered the service of the Bureau of Standards as an assistant engineer physicist. Since 1917 he has been Chief Engineer of Tests of the Aluminum Company of America. He has designed many types of testing apparatus for determining the mechanical properties of materials and has written numerous technical papers.

H. A. Marmer entered Government service in 1907, and has been continuously in the U.S. Coast and Geodetic Survey since that time. In 1920 he was made Assistant Chief of the Division of Tides and Currents, which office he still holds. He has contributed freely to technical literature.

Bruce D. Greenshields, a graduate of Oklahoma University, has made a specialty of highway work. For a number of years he had charge of the Highway Testing Laboratory at Virginia Polytechnic Institute. For the past five years he has been at Denison University as Professor of Engineering Science, in charge of the department.

E. W. Tashjian, after graduation from the University of Wisconsin, went to France with the 23rd Engineers. From 1919 to 1927 he supervised the construction of monumental buildings for the firm of Walker and Weeks, architects, of Cleveland, Ohio. His work for the Ohio Battle Monuments Commission included direction of the work on the American Hospice at Montfaucon, France.

Morris Knowles, whose previous contributions to the pages of Civil Engineering have been well received, has had wide experience in his chosen field. Pittsburgh has been the focal point of his activities, which have included design, supervision of construction, and reports on sanitary problems, water purification, flood control, housing developments, and city planning, and zoning.

J. H. Allen engaged in municipal engineering work in Massachusetts for a short time after his graduation from the Massachusetts Institute of Technology. He then specialized in sanitary engineering and for the past seven years has been associated with Morris Knowles, Inc., as assistant engineer.

C. E. Putnam has spent his entire career in the Northwest, largely in the construction of canals, railroads, buildings, transmission lines, dock facilities, roads, and water supply works. In 1927 he entered the service of the State of Washington as Principal Assistant Highway Engineer and soon became Chief Highway Engineer. He is now City Engineer of Tacoma.

Volume 2 Number 1

January 1932

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912.

Copyright, 1931, by the
American Society of Civil Engineers
Printed in the U. S. A.

CIVIL ENGINEERING

Published Monthly by the

American Society of Civil Engineers
(*Founded November 5, 1852*)

Publication Office: 20th and Northampton Streets, Easton, Pa.
Editorial and Advertising Departments:
33 West 39th Street, New York

This Issue Contains

Irrigation in Turkestan 1
Arthur Powell Davis

Triangulation Reconnaissance by Airplane 6
Noel J. Ogilvie

Building and Testing an Arch Dam Model 11
A. V. Karpov
R. L. Templin

The Basic Elevation Datum 17
H. A. Marmer

Traffic Surveys to Solve Highway Problems 21
Bruce D. Greenshields

An American Memorial Bridge in Belgium 25
Edward H. Tashjian

The Day of Opportunity 28
Morris Knowles
James H. Allen

Governmental Reorganization for Economy 30
C. E. Putnam

Hints That Help:

Laying Out a Circular Curve with Tapes 34
W. E. Howland

Spillway Discharge Calculations 34
Lewis R. East

Our Readers Say 36

Annual Meeting Programs 49

Society Affairs 57

Society Prize Winners 1931. Papers in Transactions Awarded Prizes; Long and Honorable Service Rewarded; Unemployed Engineers Improve Their Time. Half a Century of Membership; Rudolph Hering Medal Awarded. Manual No. 7—Government Services Available to Civil Engineers; Accommodating Discussers in Proceedings; American Engineering Council; Detailed Annual Meeting Program Appears in This Issue; A Preview of Proceedings; News of Local Sections

Items of Interest 64

Civil Engineering for February; Hydraulic Laboratory at the University of Iowa; If I Were Dictator. Transportation Fellowships Offered at Yale; Graduate Engineers Seek Cultural Courses; Should Your Boy Be an Engineer? Eads Bridge Arches Not Closed by Use of Ice

News of Engineers 67

Membership—Additions and Changes 68

Men and Positions Available 70

Current Periodical Literature 7

Index to Advertisers and Advertising 14, 18

The Society is not responsible for any statements made or opinions expressed in its publications.

Reprints from this publication may be made on condition that full credit be given Civil Engineering, *the author, and date of publication.*

Subscription Rates

Price, 50 cents a Copy; $5.00 a year in advance; $4.00 a year to Members and to Libraries; and $2.50 a year to Members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

Above — Bitumuls Penetration Pavement, Lake Tahoe, California.

Left — A close view of surface texture.

NON-SKID SURFACE IS TYPICAL OF ALL BITUMULS CONSTRUCTION . . . SAFETY to motorists is assured in every weather condition . . . Specify Bitumuls and obtain permanent skid-proof motoring safety, as well as smoothness and durability . . . Costs less than pavements which do not match Bitumuls' desirable features . . . Bitumuls Bulletins describe the "Modern Way to Use Asphalt". Write for them. American Bitumuls Company, Dept. 1, 200 Bush St., San Francisco.

BIT-U-MULS

Factories and Offices: BOSTON, BALTIMORE, CINCINNATI, ST. LOUIS, BATON ROUGE, LOS ANGELES, PORTLAND, ORE. *Executive Offices:* SAN FRANCISCO.

FRANCIS LEE STUART
President
GEORGE T. SEABURY
Secretary
SYDNEY WILMOT
Manager of Publications
WALTER E. JESSUP
Editor

CIVIL ENGINEERING

JANUARY 1932

COMMITTEE ON PUBLICATIONS
CHARLES H. STEVENS
Chairman
HENRY R. BUCK
L. G. HOLLERAN
EDWARD P. LUPFER
OLE SINGSTAD
W. L. GLENZING
Advertising Manager

VOLUME 2 NUMBER 1

Irrigation in Turkestan

Studies by an American Engineer to Reclaim Vast Fertile Areas in the Heart of Asia

By ARTHUR POWELL DAVIS
PAST-PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, OAKLAND, CALIF.

IN the center of the great Asiatic continent, surrounded by countries far better known, lies Turkestan, a land of mystery. It is in a huge basin draining from lofty snow-clad mountains on the southeast, near India and Afghanistan, into several inland salt seas. Although much of its area is arid, there are fertile lands along its two main river systems needing only the magic touch of water. As this country provides Soviet Russia's main supply of cotton —a basic need—American reclamation methods have been studied and are being adopted there.

In 1911, Mr. Davis was engaged to investigate the irrigation of the Kara Kum Desert lying to the south and west of the Amu Daria (River). This investigation was made at the instance of the Imperial Tsarist Government, which desired to enlist American capital in the development of irrigation in Turkestan. The investigation showed that the lands of the vast Kara Kum Desert were unsuitable for irrigation, being mostly sand dunes and alkaline wastes. Mr. Davis then made a reconnaissance of the Golodnia Steppe and recommended surveys and plans for its irrigation from the Sir Daria. Such surveys were afterwards made, and the plans now adopted are substantially along the lines recommended in 1911.

After two years as consulting engineer in Turkestan for the Soviet Government, Mr. Davis has just returned to the United States. This account of climatic and drainage conditions in a distant country throws much light on the problems awaiting solution there.

THAT part of Central Asia called Turkestan lies between China and the Caspian Sea, with Siberia on the north and Persia and Afghanistan on the south. It covers an area larger than that section of the United States east of the Mississippi River.

In its southwestern and southeastern parts, Turkestan consists chiefly of lofty mountain ranges, which reach altitudes above 20,000 ft. and are crowned by perpetual snow. As this accumulates on the upper slopes its weight forces it to flow down the canyons in the form of glaciers, until in summer it reaches altitudes low enough to encounter the dominating influence of the sun. Then the ice melts until the edge of the glacier recedes to approximately the position it occupied the previous autumn, and the annual cycle is repeated.

These glaciers feed large rivers, none of which, however, reaches the ocean. Most of them are lost in the desert or used in irrigation. Only the two largest, the Amu Daria and the Sir Daria, reach the Aral Sea. Some lesser streams flow eastward into Balkhash Lake, a much smaller inland basin. Both these bodies of water, shown in Fig. 1, are salt and have no outlets.

Archeological investigations have shown that the principal valleys of Turkestan have been occupied for many centuries by various races and tribes who cultivated the soil and raised domestic animals. As most of the country is arid, it is probable that irrigation was practiced thousands of years ago. The country was repeatedly invaded by Chinese, Turks, Mongols, and Tartars, who in turn conquered the valleys, destroyed much of the previous development, and substituted their own.

In 1860, the last conquest of Turkestan was begun by the Russians. At that time the country was divided into numerous petty kingdoms, or Khanates, which were successively conquered by the Tsarist armies and consolidated under a viceroy into a single province. Its capital was established in Tashkent, in the valley of the Chirchik River, 1,200 miles east of the Caspian Sea.

These Russian conquerors instituted many improvements. Railroads were built and irrigation was encouraged and extended. New cities were laid out, having wide streets lined with trees, of which the country stood in great need. It is said that over 50,000,000 poplar, maple, mulberry, elm, and other forest trees were thus planted and served with irrigation works. Today they add greatly to the beauty and comfort of the cities and their environs.

The climate of Turkestan is arid and of the continental type, with hot, dry summers, and relatively cold but short winters. It is favorable for the growing of cotton, which is widely cultivated, and also for the production of rice, fruit, and other products of the warm temperate zone. The meager rainfall of this region is practically all precipitated in the winter and spring.

In Turkestan the principal rivers offering opportuni-

RIVER PROTECTION WORKS IN TURKESTAN
Gabions or Mattresses Made of Boulders Held Together by Wire Nets to Prevent Erosion by Running Water

ties for irrigation are the Amu Daria, with its mountain tributary, the Vaksh; the Zeravshan; and the Sir Daria with its tributaries, the largest of which are the Narin, the Kara Daria, and the Chirchik. Their relative importance is indicated in Table I.

These rivers derive their water supply mainly from glaciers, but their flow is augmented by snow, which begins to melt in the lower foothills late in March. They attain a considerable volume in April, usually reaching a peak in May. As this supply declines, the sun begins to make vigorous attacks on the glaciers, and as the heat of summer increases, the flow from the glaciers reaches its peak, usually in July, producing the maximum water supply of the season.

TABLE I. IMPORTANT RIVERS OF TURKESTAN

RIVERS	MEAN ANNUAL DISCHARGE Acre-ft	VALLEY AREAS	
		Total Acreage	Now Irrigated
Amu Daria	53,200,000	9,754,000	1,100,000
Zeravshan	4,160,000	1,875,000	980,000
Sir Daria	15,000,000	5,000,000	2,190,000
Chirchik	7,120,000	1,730,000	480,000
Totals . . .	79,480,000	18,359,000	4,750,000

Thus the principal rivers of Turkestan are marked by two peaks of flow each year, the first in May or June, and the second and higher peak about a month later. August also is usually a high-water month, but the flow rapidly declines during late August and September, and the minimum stage is usually about midwinter.

Largest of the Turkestan rivers is the Amu Daria, formed by the junction of the Pianj and the Vaksh. It drains an area of 90,000 sq. miles, and includes a system about 1,600 miles in length.

The upper half of the river and all its tributaries are in mountainous country, called the Upper Region, from which they receive their entire water supply. Below this the river receives no tributary waters but loses water during the summer by evaporation and seepage. From the point where it leaves the mountains to the head of its delta, the valleys are few and narrow. This section is called the Middle Region. Below is the Delta Region,

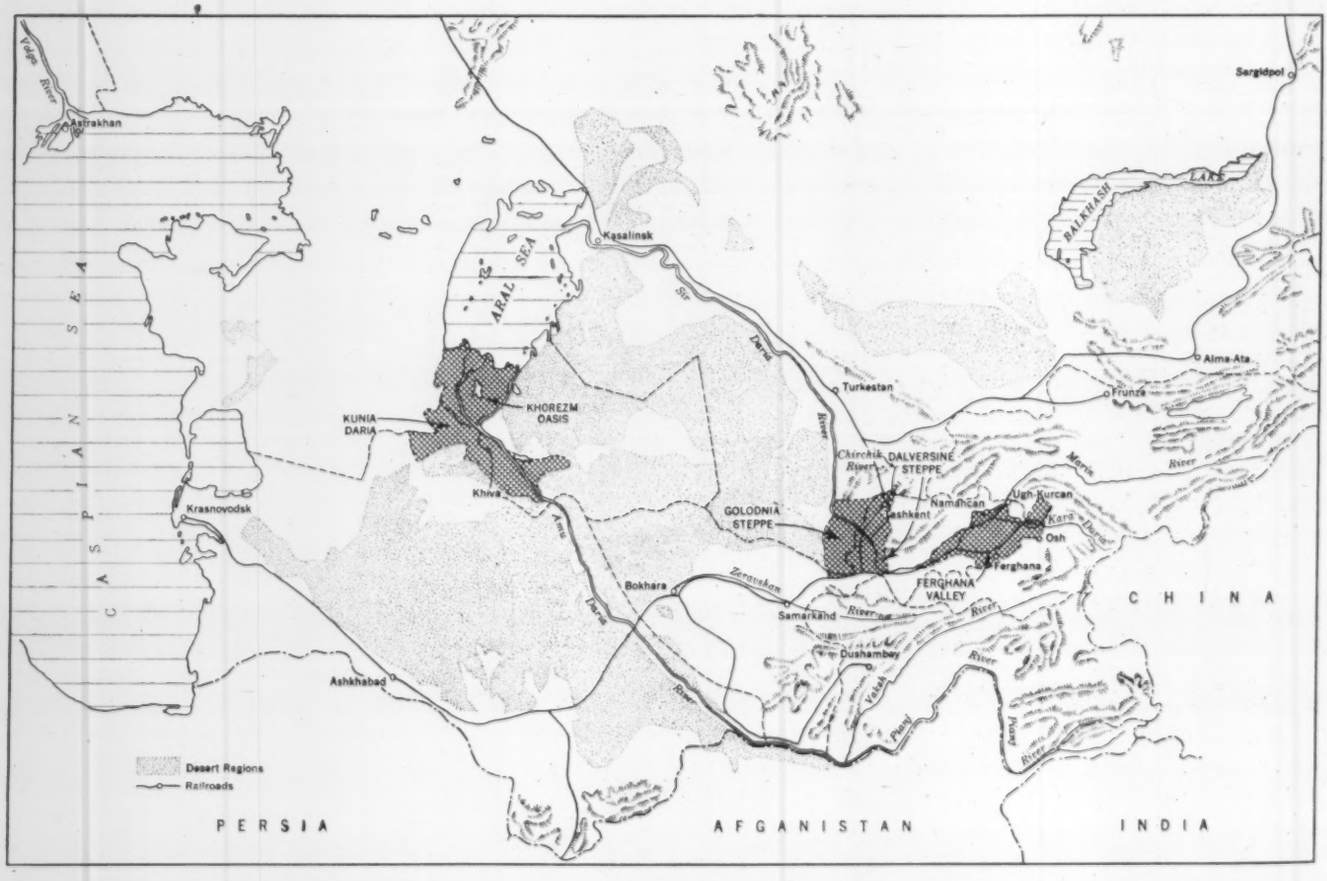


FIG. 1. MAP OF TURKESTAN
With Principal Cities, Geographical Features, and Some Irrigation Projects

extending to the Aral Sea and containing two-thirds of the total valley area.

Irrigation possibilities on this river system vary considerably, as shown by Table II. In the Upper Region, in the valley of the Vaksh, there are about 100,000 acres of land already irrigated, which area it is proposed to double by construction in 1931 and 1932. The water supply is ample without storage, and the suitability of the region for cotton culture has been proved. Some experiments indicate that it is also adapted to the growing of long, staple varieties.

TABLE II. IRRIGATION ON THE AMU DARIA
Present and Future Requirements, in Hectares

REGION	NOW IRRIGATED	TOTAL PROPOSED
Upper	108,000	665,000
Middle	89,000	195,000
Delta	245,000	2,278,000
Total	442,000	3,138,000

In the Middle Region, where there are numerous existing canals, irrigation is greatly hampered by the shifting nature of the river channel, which is apt to leave the canal headings, or to cut them away on short notice in the midst of the farming season. Excessive deposits of silt also cause much trouble in the canals.

By far the most important part of the Amu Daria Valley, from an irrigation standpoint, is the Khoresm Oasis, shown in Fig. 1, in the delta of the Amu Daria, south of the Aral Sea. It covers an area of 9,000,000 acres of valley land, between latitudes 41 and 43, of which over one-half is probably irrigable, and the rest is mostly swamp, and alkaline or sandy wastes.

The oasis is divided topographically into four rather indistinct regions, each with different irrigation prob-

BUILDING A CANAL BY HAND LABOR IN TURKESTAN
Most Earthwork, Including Construction and Repairs, Is Done by Hand, but Machinery Is Gradually Being Introduced

lems. The total area amounts to 4,170,000 hectares. Of this, 1,870,000 hectares are completely fit for irrigation, 320,000 require slight reclamation, 660,000 require heavy reclamation, and 760,000 are totally unfit for reclamation. In addition there is a considerable acreage which is flooded or covered by shallow lakes.

A few centuries ago, the Amu Daria flowed westward to the Caspian Sea. It later changed its course and now flows northward into the Aral Sea, which has a surface area of 26,000 sq. miles. The Kunia Daria is the name given to the former river channel and valley of the Amu Daria in the Khoresm Oasis. The old channel may still be seen, although largely filled with sand and entirely dry.

Numerous canals and villages, now in ruins, all testify to an ancient development. It is proposed to irrigate the Kunia Daria Valley, which forms nearly half of the

NAVIGATION ON THE LOWER AMU DARIA AT TASH SAKA
The Amu Daria Is Shallow and Full of Sand Bars Except at High Water, When It Is Very Swift. It Is Therefore Difficult to Navigate, Especially Upstream

Khoresm Oasis. This and other large irrigation enterprises will consume most of the water of the Amu Daria and it is planned to discharge the remainder, including abnormal freshets, down the old Kunia Daria channel.

All the irrigable lands of the Khoresm Oasis will be served from two diversion points, the uppermost of which is at the place where the river enters the delta and is all in one permanent channel. A dam at this point can be made to take the place of four main diversions, and several minor ones. From this dam about 1,400,000 acres of good land can be reached, and the waste of multiple diversions can be avoided. The dam would be provided with sluicing works to dispose of the heavier sediments, and the canals would have suitable regulators.

The remainder of the Khoresm Oasis is to be irrigated by means of a suitable diversion farther downstream. There a dam with sluicing works is proposed, from which water will be taken through regulators into six different channels running in various directions from the southwest to the west and north.

Consumption of most of the waters of the Amu Daria for irrigation, and discharge of the remainder down the Kunia Daria to the westward, will deprive the Aral Sea of its principal feeder. Its surface will then diminish by evaporation to such an extent that considerable alluvial land along its southern boundary will be uncovered, and this will add materially to the irrigable area of the delta.

The problems of irrigating the Khoresm Oasis are complicated by a high water table under extensive areas, which will demand care in irrigation and extensive provisions for drainage.

Second in size among the rivers of Turkestan is the Sir Daria. Like the Amu Daria, it is fed by glaciers and flows into the Aral Sea. It is formed by the junction of the Narin and Kara Daria in the lower part of the

Ferghana Valley. This valley is the largest in the basin, and was the scene of an early irrigation development—the largest in Turkestan. The valley has long been noted for its production of cotton. Besides the Narin and Kara Daria, it receives the waters of about thirty smaller streams, which enter from the south. These rivers are all used for irrigation at their own deltas, where their waters are mostly consumed.

MODERN MACHINERY IN TURKESTAN
Drainage Construction on the Golodnia Steppe

Crude native canals without regulators at their heads receive large quantities of water in times of flood. This water is not needed for irrigation and is only partly used, thus causing swampy conditions in the lower reaches. In this way over 500,000 acres, otherwise fertile, are water-logged. Their reclamation is the major problem of the valley.

Like its small tributaries, the Kara Daria is over-appropriated, but the Narin has a large amount of water that runs to waste into the Sir Daria. Extension of irrigation requires that the surplus waters of the Narin be carried to the southward across the Kara Daria and applied to the land that needs them. The native canal systems also require reconstruction. A beginning on this work has been made by the Soviet authorities, chiefly in providing regulators to control the waters before they are used for irrigation.

No favorable storage reservoir sites are known in this basin, except one on the Kara Daria, which would be an expensive development and is only contemplated for the distant future. The irrigation development of the Ferghana Valley has been largely carried out by small enterprises, resulting in a vast number of diversions and canals which are parallel to each other and very wasteful in operation. For example, one river, the Sokh, has 96 ditches leading from it at different points. These could be consolidated with advantage into two or three. The present works are wasteful of water and of the labor required for their operation. In addition they occupy large areas unnecessarily. While great improvement is possible by consolidating headings and eliminating most of the canals, it would require a great deal of expense. The problem is difficult from both economical and physical standpoints.

Through the heart of the water-logged region a main drainage canal is proposed to receive the waste waters from the canals that terminate nearby and to drain the swampy areas. In this way a large amount of water can be conducted to the Sir Daria, for use in irrigating the region below.

On both sides of the Sir Daria, along its middle course, are sizeable territories adapted to improvement by irrigation. These are the Golodnia and the Dalversine steppes. The Golodnia Steppe is a large area now mostly in a desert condition, lying to the south and west of the Sir Daria. On the opposite side of the river is the Dalversine Steppe, smaller in size and partly irrigated, to which canals are being built to improve the present systems and feed the irrigated lands. The total available area in the Dalversine Steppe is about 100,000 acres, of which about one-third is now irrigated in an unsatisfactory manner. The works for this development, which are practically completed, consist of a main canal diverting waters from the Sir Daria above the head of the valley without a diversion dam, but with modern regulating gates. This is the first considerable irrigation project thus far accomplished by the Soviet Government.

On the left bank of the Sir Daria is the Golodnia Steppe, a vast area of over a million acres of excellent land. The lower part of it is already irrigated by a main canal provided with regulating works built before the Soviet Revolution, but not with a diversion dam.

At this point it was proposed to build a type of diversion weir known as the Begovat weir, a massive sill of concrete provided with a series of gates. The gates would be left open during the winter and would be opened in the summer to discharge any surplus water not needed for irrigation. Part of the land already irrigated has been damaged by seepage, and drainage works of some kind are required to remedy this condition. The absence of deep natural drainage makes the seepage problem in the whole area very important. It is planned to line the greater part of these canals in order to conserve their waters and especially to make drainage easier by preventing seepage. The Golodnia Steppe presents many problems but it constitutes one of the most interesting and promising developments of new land yet proposed in Turkestan.

COTTON PRODUCTION A VITAL NEED

Turkestan is of great importance to Russia as a producer of cotton, a crop successfully raised in the main river valleys, in all of which its production can be increased. With the exception of a small area in Transcaucasia, Turkestan is the only part of Russia that grows any considerable quantity of this product. This vast nation of nearly 150,000,000 people, even with its low standard of living, consumes more than twice as much cotton as it produces. Many articles are made of linen which in other countries would be of cotton or cheaper fibers, such, for example, as tents, bags, tarpaulins, and laborers' coarse clothing. The imported cotton comes from India, Egypt, and the United States.

About 1880 it was realized that it was desirable to diminish these imports by increasing Russian production. So the authorities introduced American cotton seed to take the place of inferior native varieties, and began the encouragement and improvement of cotton culture. Native cultivation of cotton was improved in all the main valleys of Turkestan where the climate was favor-

able, but the World War, the socialist revolution, and especially the civil war that followed, played havoc with cotton culture, as well as with most other forms of agriculture and industry. Statistics show that in 1924 production of cotton in Russia was less than one-third as much as in 1915. Although the increase since 1924 has been continuous, the total production, as shown in Table III, is still below the pre-war level.

TABLE III. PRODUCTION OF COTTON IN THE SOVIET UNION

YEAR	PLANTED AREA 1,000 ACRES	RAW COTTON Long Tons	COTTON FIBER Long Tons	RAW COTTON Lb. per Acre
1915	2,041.6	1,139.2	322.6	1,240.0
1924	1,105.6	335.8	96.6	678.0
1925	1,460.4	534.2	154.7	821.0
1926	1,615.3	529.1	159.7	740.0
1927	1,906.0	682.2	212.8	830.0
1928	2,286.4	777.2	241.2	776.0
1929	2,607.1	810.5	259.8	714.0
1930*	3,097	950	300	688

* Production for 1930, approximate

In these statistics the most striking feature is the decrease in production since 1915. Although the acreage planted in 1930 was 51 per cent greater than in 1915, the yield was 7 per cent less. This represents a decrease in yield per acre of cotton fiber of about 45 per cent; the last four years show a progressive decrease in the acreage yield.

Various reasons are assigned for this, such as lack of irrigation water early in the season; lack of proper cultivation and fertilizers; and the tendency to plant on lands having a shorter growing season. But our information is not sufficiently definite to show which of these causes was the most potent.

ENGINEERING PRACTICE IN THE SOVIET UNION

The Soviet Government takes American practice as a model in most economic fields, including irrigation. Plans were made for utilizing American engineering talent but those plans have not fully materialized, owing chiefly to financial difficulties. However, some American engineers are still occupied with irrigation, and negotiations with others are said to be under way.

Every bureau or important project has for its head a communist "member of the party," under whom the engineers serve and to whom they report. In addition there is usually an assistant, also a communist "member of the party," who has the usual functions of an assistant chief. All recommendations or actions of the engineers are subject to review and modification by these communists, who usually are not engineers and who, as a matter of fact, have little or no power to determine anything. The Soviet bureaus are especially weak in having no centralized responsibility. All actions and recommendations are subject to reference from one authority to another, and hence are subject to great delay and confusion.

There are still many Russian engineers with excellent education and experience engaged upon engineering work in the Soviet Union. Although they lack experience in modern irrigation methods, they have fairly well mastered the technical literature of foreign countries. The author saw no indication of sabotage or other evidence of disloyalty to the work in hand and received courteous treatment from all.

Except in a few good hotels in Moscow and Leningrad, living conditions throughout Russia, and especially in Turkestan, are very primitive. Sanitary appliances are crude and unskillfully operated. Luxuries are unknown, and the common necessities of life, such as shoes, clothing, household equipment, and many staple articles of food, are hard, and sometimes impossible, to obtain.

The paper money in common use as exchange has

AT THE HEAD OF THE BOZ-SOO CANAL

"Sepoys" or Rude Tripods Used in Handling and Stabilizing the Gravel Dikes Employed to Divert and Control the Water

greatly depreciated and fluctuates in purchasing power. Even with proper authority, in the form of a contract or permit, it is very difficult to import anything owing to the great number of ever-changing regulations and endless delays. Everything obtainable in Russia is relatively costly. United States money can be used in the cities; and in some of the stores and hotels Russian currency is not accepted. Foreign currencies are received at a given ratio to the American dollar, which is the standard for foreign currency.

Native currency cannot be taken from the country or brought in from abroad. All foreign currencies can be exchanged at the business centers for Russian currency in the ratio of one ruble for 51.4 cents of American money, although this is many times the actual value of the ruble in purchasing power. On leaving Russia, a foreigner is required to surrender all his Russian currency without compensation. If he expects to return he may take a receipt, on presentation of which this currency is returned for use in Russia.

AMBITIOUS PLANS AWAIT THE FUTURE

In 1929 I was retained as Chief Consulting Engineer on Irrigation for Turkestan and Transcaucasia, for a period of two years, recently ended. My duties, which were advisory only, consisted of the examination of surveys and plans, inspection of the territory under consideration, and the giving of advice as to necessary changes and further work to be undertaken.

A very ambitious plan of irrigation construction was projected, but the world-wide business depression greatly crippled the markets for Russian exports, and it became necessary to curtail or postpone most of the work not already started. Therefore little of the irrigation program has been so far carried out except the preparation of plans for future development.

Photo by Royal Canadian Air Force

TYPICAL CANADIAN LAKE AND FOREST COUNTRY
Land Transportation Difficulties Make Aerial Reconnaissance Economical

Triangulation Reconnaissance by Airplane

Canadian Geodetic Survey Develops a Successful Method

By NOEL J. OGILVIE
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DIRECTOR, GEODETIC SURVEY OF CANADA
DEPARTMENT OF THE INTERIOR, OTTAWA, CANADA

WITHIN the past decade or so the airplane has become a very useful tool of the engineer, surveyor, and mapper. Since 1929 it has been extensively employed by officers of the Geodetic Survey of Canada, not only for the transportation of geodetic parties from point to point, but also to solve the interesting problem of selecting sites for triangulation stations. The economy and satisfaction that have resulted from its use in this connection make the extension of the method in the future a matter of little doubt.

ONE of the first applications of aerial methods to surveying and mapping in Canada was carried out by H. F. J. Lambart, of the Geodetic Survey staff, in 1921, when the reconnaissance for a net of triangulation some 200 miles long was made by airplane in the mountainous district northeastward from Vancouver, the results being checked by ground visits to all stations. Although the advantages of the airplane for reconnaissance in mountainous districts were recognized as early as 1921, it was not until 1929 that it was realized that the method could be successfully applied to less rugged areas.

In February and March 1929, J. L. Rannie, Chief of the Triangulation Division, and F. P. Steers, Geodetic Engineer, undertook two aerial reconnaissance operations over lake and river areas 75 miles and 115 miles long, respectively, during which considerable useful experience was acquired. To these officers of the Geodetic Survey of Canada and to officers of the Royal Canadian Air Force, in whose planes all reconnaissance operations have been conducted, is due the credit for the development of the methods here described.

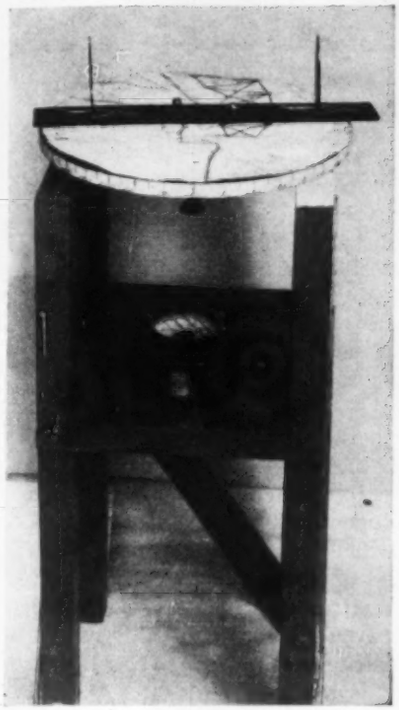
During the summer of 1929, two reconnaissance operations by officers of the Geodetic Survey of Canada were carried out by aerial methods, in planes flown by pilots of the Royal Canadian Air Force. Again, in February 1930, an additional 100 miles was covered by airplane, and in the winter of 1931 a more ambitious program was undertaken. In about four weeks of January and February 1931, a net 720 miles long was laid down in northern Ontario by two engineers operating with separate airplanes from a common base, and in March the reconnaissance for 185 miles of triangulation was completed in the province of Saskatchewan in three flying days.

The country covered by airplane reconnaissance previous to March 1931 was well watered and had considerable relief, the heights of the higher hills being from 300 to 1,000 ft. above the waterways. In March and April 1931, experience was gained in flat, well watered country in which the height of the hills was less than 100 ft. above the waterways. Also in 1931 one dry area was encountered in which it was decided that no reconnaissance could be done in safety with the single-motored planes which have been used so far.

The principles of aerial reconnaissance as developed by Geodetic Survey officials should be briefly stated because they vary somewhat from those of ground reconnaissance. Over lakes or other territory where comparatively low flying can be done in safety, the plane is flown approximately at the height of the higher ridges. From this position outstanding hills suitable for triangulation stations may be selected, the comparative heights of the hills can be determined, and in many cases the intervisibility of certain hills can be tested, either by direct observation or by inference from other data which can be obtained.

For ground reconnaissance a prismatic compass, protractor, ruler, and map make up the equipment most commonly used. For aerial reconnaissance a small apparatus on the plane-table principle has been designed which combines all these in one instrument. It consists

of a small four-legged stand which is screwed to the floor of the plane. On a shelf of convenient height a good airplane compass is mounted, while at the top is a circular, revolvable plane table 14 in. in diameter, with a scale in degrees painted around the edge. The best available map of the area is used on the plane table. A scale of about 8 miles to an inch covers a convenient area and is sufficiently large to portray the main topographical features of the country clearly and legibly. A parallel ruler provided with open sights is used as an alidade.



AERIAL RECONNAISSANCE EQUIPMENT
Built on the Plane-Table Principle and Screwed to the Fuselage Floor

When the stand has been firmly attached to the floor of the airplane, the compass is swung and corrected for local deviation by means of a corrector-magnet box which is screwed directly under the compass on the under side of the shelf. The compass is then read and a line corresponding to the magnetic bearing is drawn across the center of the map. The plane table is revolved until its reading is the same as that of the compass, and the map is turned on the table until the bearing line drawn on the map is parallel to the center line of the fuselage. In this position the map is pinned to the plane-table board.

In the air the operating procedure is simple. When flying on any course the compass is read and the circular plane-table board revolved until its reading is that of the compass. This takes only a few seconds. The map has now been oriented and, with the parallel ruler, is used as an ordinary plane table for locating the positions of hills by intersection, according to the usual plane-table procedure.

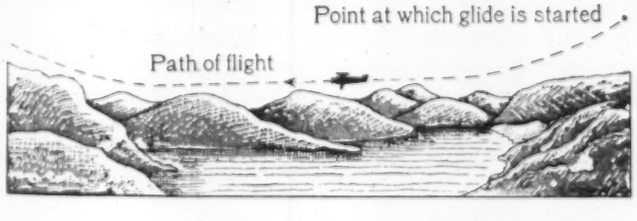
Results secured with this apparatus and method are somewhat rough. The small residual errors of the compass are likely to change because of tools and other iron substances which may be stowed away in the plane in different positions at different times. The maps of the country may be inaccurate or incomplete, and hence the position of the plane may be a matter of considerable doubt. With the plane moving a mile every thirty or forty seconds, its position, even with the best of maps, is a matter of some uncertainty. Any unevenness of the atmosphere which causes a swing of the compass needle will also preclude a high degree of accuracy in plotting the rays from the plane. But in spite of all these sources of error the positions of hills can be plotted from as far as ten or fifteen miles away within a mile or so of their true locations.

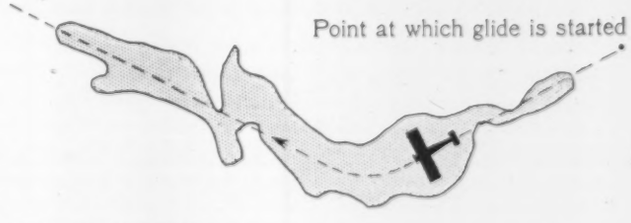
The type of plane used is an important factor. A cabin plane is advisable, especially in winter, and it is necessary that there should be room for mounting the plane table, and good visibility from inside the cabin. The motor should develop sufficient reserve power to enable the plane to climb rapidly on encountering hills after flying low over small lakes and rivers. Although single-motored planes have been used up to the present, their use has been considered unduly hazardous for regular aerial reconnaissance over dry, forested areas. It seems possible that bi-motored planes will solve the difficulty.

LOW FLYING NECESSARY

Quite as important as the plane is the skill of the pilot. Aerial reconnaissance provides ample opportunity for hazardous flying if the pilot is willing to take the risk. While the hazardous method may be the easiest for obtaining the desired information, this fact should not dictate the flying technic to be used. A pilot should be selected whose judgment can be relied on as to what flying can be done in safety and what should be avoided. On the other hand, the pilot must not be unduly cautious or the success of the operation will be circumscribed. Trouble is seldom encountered through the over-caution of pilots; generally the reverse is the case. For this reason the following instructions to pilots have been deemed necessary. "The reconnaissance flights necessarily involve some low flying in order that the geodetic observer may obtain lines of sight between hills. Pilots are to undertake this low flying with caution, having regard to engine failure. If any particular request is considered hazardous the observer should be advised accordingly and be requested to propose an alternative course."

When a reconnaissance engineer goes to a new area the following flying procedure is typical of that employed. Certain lakes or rivers are picked out on the map as of desirable size from which to choose the hills to be selected as triangulation stations. Low flights are then made





SELECTING HILLS FOR TRIANGULATION SITES
By Flying Low Over a Lake to Test Intervisibility of Points

Photo by Royal Canadian Air Force

TYPES OF PLANES IN USE FOR TRIANGULATION RECONNAISSANCE
At Left: With Pontoons for Summer Work
At Right: High-Powered Cabin Plane with Ski Landing Gear

over these lakes in a series of straight lines—as few as possible to avoid lost time for the compass to settle down and the map to be oriented. Before beginning his glide to the lower level, the pilot should manoeuver his plane to a position on the first course at such a distance from the lake that he will reach the proper elevation over the beginning of the lake. Thus the engineer is given the full length of the first course with his compass stable and map oriented. The elevation at which he signals the pilot to fly depends altogether on the heights of the hills and their distances from the plane. If they are close by he needs to fly very little above them, whereas distant hills stand out in relief from a higher level. Outstanding hills are cut in while flying low, but subsequently it is usually found advisable to fly at a safe height above them and check their positions by reference to the surrounding topography, as shown on the map.

COMPARING HEIGHTS OF HILLS

To compare the heights of two hills to decide which is the better site, the plane is flown at such an elevation that the top of one of them is directly in line with the horizon, by reference to which the relative height is generally evident. While the selection and plotting of possible triangulation stations are proceeding, the engineer can judge to a considerable extent the intervisibility of certain hills and is enabled to lay out a tentative scheme of triangulation, certain lines or parts of which may need to be checked or added to, either at the time or on a subsequent flight.

Gradually the triangulation net is extended by flying into new territory, the engineer taking advantage of any lakes for the necessary low flying. Just as the ground reconnaissance engineer finds it necessary to suit his operations to the topography, to obtain the best geometrical conditions for the completed triangulation, so also must the engineer on aerial reconnaissance modify his flying operations to be consistent with safe flying.

In checking the intervisibility of stations the flying procedure varies with the availability of water. Occasionally it is possible to fly in a series of courses around a hill and actually sight over the hill toward the various other stations. Obviously this procedure has many limitations, but other expedients can be used. Usually it is possible to fly low over a lake between two stations, keeping the nearer of the two in line with the horizon, as at that elevation the plane is reasonably close to the line between the two hills. A sight toward the other station will then frequently enable the engineer to judge whether or not a line is open. Even though he cannot distinguish the farther station he will conclude that it must be visible, if it is higher than anything else in its immediate vicinity.

It has been found that blocked lines are seldom encountered after an aerial reconnaissance by an experienced engineer. More generally it is later found that a few lines are open which the engineer believed closed, and a ground check of the aerial reconnaissance may reveal possibilities of simplifying the net.

In aerial operations in flat country it is rather seldom that actual sights between triangulation stations can be taken, as the engineer cannot pick out the distant hills on account of their inconspicuousness and the speed at which he is flying. Sometimes all he can do is to estimate the distance he can see from the plane's position level with the top of a near hill. Experience will teach the probable length of line usually obtained in any type of country with certain heights of hills.

In flat country, curvature and refraction are the essential difficulties to be overcome, and the well known formulas for combined curvature and refraction are either consciously or unconsciously applied in aerial work.

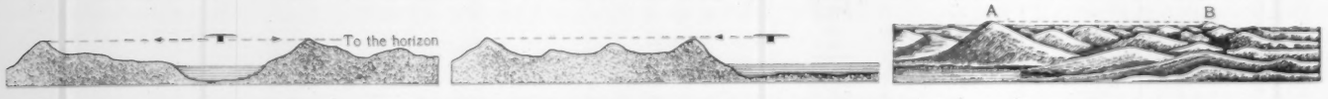
$$H = 0.574\, s^2, \text{ or}$$

$$s = \frac{4}{3}\sqrt{H}$$

where

H = the height of the hill in feet, and
s = the distance in miles to the horizon.

Opinions differ, as yet, regarding the necessity or advisability of checking the aerial reconnaissance by ground visits to the stations in rugged country, before station-preparation parties and observation parties are sent into the field, but there is no disagreement as to the necessity of ground checking in flat country, as in this type of country the aerial engineer is much less sure of his conclusions. It is obviously an economy if the ground checking can be eliminated or if it can be re-



TESTING THE INTERVISIBILITY OF STATION HILLS
When *B* Can Be Seen from a Point Near and at the Same Level as *A*, the Intervisibility of *A* and *B* Can Be Readily Judged

duced to such small proportions that it can be done by the skillful foreman of a station-preparation party.

Engineers who have not done aerial reconnaissance work are sometimes mildly astonished at the completeness of the description of the station turned in by the aerial reconnaissance engineer. An example will indicate the type of data which are commonly secured.

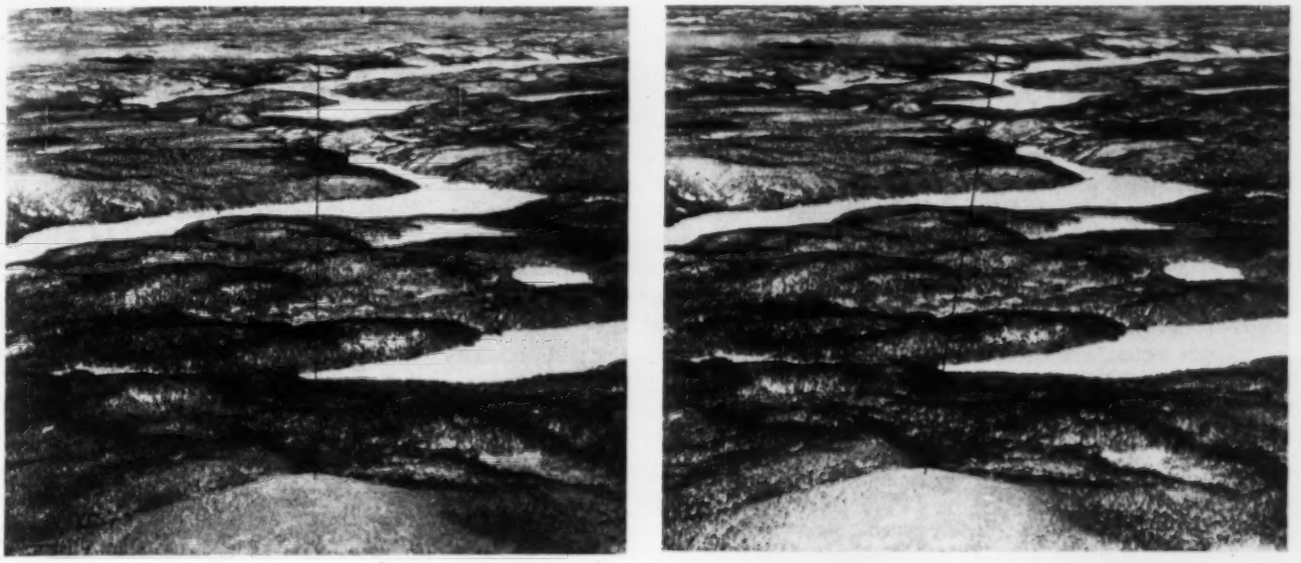


Photo by Royal Canadian Air Force

STEREOSCOPIC OBLIQUE PHOTOGRAPHS DETERMINE INTERVISIBILITY OF HILLS

Examination Under a Stereoscope Shows a Line Drawn Between Two Stations as a Taut Cord Joining the Hilltops and Passing High Over the Intervening Country

"On the third hill from the north end of McIntyre Peninsula near its easterly side. The second hill from the north end of the peninsula is the highest of the group and would have been selected as the station, but the line to Albert Station would have grazed the top of the hill finally selected, whereas the lines from the third hill are clear of all grazing rays close to the station. The hill is covered with a fairly heavy growth of deciduous timber, and there is probably soil covering, possibly with underlying rock. A combination of a short tower and line cutting is probably necessary. A plane can land on the lake at the base of the hill, and a steep climb of three-quarters of a mile in a westerly direction will lead one to its summit."

This description is complete enough for the average foreman of a station-preparation party, except for the lack of the bearings of lines to other stations, which must be scaled from a map and are in error if there are any inaccuracies in plotting the positions of the stations.

Such details as the selection and marking of the best route to a hill, the magnetic bearings to other hills, the best site for a station, and decisions as to whether a tower or lines cut through the timber on the hill top or a combination of both, would be the more suitable, are ones which can best be settled by ground visits; and properly they should be decided by the reconnaissance engineer. If such matters were left to the foreman of the station-preparation party, a higher type man would have to be chosen than is sometimes employed on such work. The policy of the Geodetic Survey of Canada will be to ground-check all aerial reconnaissance until such time as it is shown that essential data is being obtained from the air. It is to be noted that the ground checking is done very quickly, because of the information gained by airplane regarding the positions of hills and the method of approach.

As a result of operations in northern Ontario and Saskatchewan in the winter of 1931, the data in Table I were made available, from which progress and costs can be estimated. In arriving at these figures, the flying time going to and returning from the reconnaissance area has not been included, as this naturally varies with the distance of the area from the permanent airplane base. Also, extra engine time on the ground has not been allowed for, as it is negligible in the summer but appreciable in the winter, when considerable warming up of the engine is necessary. In any estimate of fuel consumption for laying in supplies of gasoline and oil, or for estimates of cost, allowance for these items should be added to the figures calculated from Table I.

TABLE I. DATA FOR TWO AERIAL RECONNAISSANCE SURVEYS, MADE IN THE WINTER OF 1931

ITEM	720 MILES IN NORTHERN ONTARIO	185 MILES IN SASKATCHEWAN
Axial distance along net per flying hour	11 miles	12 miles
Area covered per flying hour	223 sq. mi.	218 sq. mi.
Stations selected per flying hour	1.7	1.2

Two main limitations of the aerial reconnaissance method are that the intervisibility of stations cannot always be assured by safe methods of flying, and that the bearings of lines are only available from the map, so that their precision depends on the accuracy with which the stations are plotted. Experiments have been undertaken to discover whether oblique stereoscopic photographs will aid in the solution of these difficulties. While the problems appear possible of solution by this means, its success to date has not been sufficient to justify the cost of taking the photographs.

In these experiments the plane is flown at right angles to a triangulation line, and two or three oblique

photographs are taken along the line in question. The position of the plane is such that one station appears in the foreground of the photographs and the other in the background. A height of 5,000 ft. has been found suitable for taking such photographs. To obtain the stereoscopic effect, the camera is pointed at the same point on the horizon; in other words the center lines of the photographs are parallel. Also the exposures are made as quickly as possible—about three or four seconds apart with hand winding of the camera film—to avoid lack of stereoscopic effect due to drift.

The photographs are examined under a stereoscope and the triangulation stations identified. These stations are joined by fine lines. Under the stereoscope, the lines in adjoining photographs merge and stand out as vividly as a taut cord joining the hill tops. With experience, any major obstruction to intervisibility can be detected, for the line will appear to intersect the obstruction.

Although the experiment has not yet been tried, there appears to be no insuperable reason why the magnetic bearings of the lines cannot be determined from the photographs. A compass mounted on the camera would give the bearing of the center line of the photograph, and the bearing of a line between two hills could be obtained from the center line bearing by the use of suitable transparent grids, such as are used for plotting oblique aerial photographs. Another promising method of obtaining the bearings of triangulation lines from the air is to fly over one station toward another and read the bearing on the plane-table compass.

The main objections to the photographic method are that the distant station cannot always be recognized in the photographs, and that, where a line grazes an intervening hill or is blocked by a few feet of intervening ground or timber, the methods at present employed are not sufficiently decisive. Experiments have covered cameras with focal lengths from 8 to 20 in. and a variety of filters and emulsions. The best results have been obtained with a 20-in. lens and a minus blue filter. The investigations will be continued.

In all experiments for obtaining essential data from the air, value and cost are important factors which must be compared with the small cost, the satisfaction, and the reliability of ground checking after aerial reconnaissance.

GOING UP FOR THE FIRST TIME

When an engineer, even one experienced in ground reconnaissance, first goes up for aerial reconnaissance he meets considerable difficulties. As the data required cannot generally be obtained in the same way as on the ground he has to become familiar with a new technic. He does not know just how to fly to get the data he requires, nor does he know what is safe flying and what is not. He is apt to ask the pilot to fly where it is not safe and he probably cannot think of any alternative when the pilot says "no." His mind is in a whirl because of the speed with which the data must be obtained and assimilated and his plans made. On account of this difficulty he seldom gets all the necessary data on the first flight, and subsequent flights are required to supplement those first obtained.

He cannot tell what data are acceptable when obtained by indirect methods and what can only be obtained by ground checking. In addition, he is so uncertain as to the reliability of his impressions that he wishes for the presence of some experienced man to confirm them. While he is still trying to absorb the information he has obtained and to decide how it will fit into a triangulation system the plane comes to the end of a lake, and the pilot asks, "Where shall I go next?" He is apt to express a wish that this speed demon would sit down for half an hour so that he can consider all the data before he makes further plans.

Gradually this feeling of uncertainty passes; fuller information is obtained; decisions are made instantly as to what further flying, if any, is required in that area, and what the next plans for flying are to be. Obviously, successful and economical aerial reconnaissance depends on a combination of expert pilot and proficient aerial geodetic engineer.

METHOD IS FAST AND SUCCESSFUL

Conclusions to be drawn from the aerial reconnaissance carried out in Canada are that the method is especially applicable to areas where transportation is difficult. Even if ground checking of air work is necessary, the method is decidedly economical and to an unbelievable extent faster than ground reconnaissance; and with suitable planes it is believed that the system can be extended to dry areas at present largely avoided. Owing to the speed of the method, a triangulation system can be laid out over large areas by a very few reconnaissance engineers many years sooner than it could be done by ground methods, and years in advance of the final operations.

This in itself has a number of advantages. Main and secondary triangulation schemes having been laid out, operations which are required in isolated sections can be completed, on an astronomical datum if necessary, with a degree of accuracy which will make them fit in with the final net as laid out for the whole country. Another advantage is that station-preparation and tower-building parties can be put into the field at least a year earlier than could be expected if the reconnaissance had to be carried on by ground methods. In parts of the country, such as northern Ontario, where a program of building steel lookout towers for fire detection is in progress, the triangulation stations offer a valuable choice of hills as sites for these towers. When towers have been built by the foresters and trails and telephone lines installed, these towers are of great assistance when a triangulation net is being completed. In such a case it is quite advantageous to forestry and geodetic officials to have the triangulation net laid out well in advance of subsequent operations. In the absence of a small army of trained ground reconnaissance engineers, these advantages can only be secured by the use of the airplane.

Considerable success in aerial reconnaissance for triangulation in well watered country has already been secured. While there are several phases of the problem for which a complete solution has not yet been obtained, and while dry areas have been avoided, the progress to date is sufficient to encourage the hope that more experience and suitable types of airplanes will provide a solution for the whole problem.

Building and Testing an Arch Dam Model

Engineering Replica of Calderwood Dam Constructed on Yielding Foundation

By A. V. KARPOV AND R. L. TEMPLIN
MEMBERS AMERICAN SOCIETY OF CIVIL ENGINEERS
DESIGNING ENGINEER AND CHIEF ENGINEER OF TESTS, ALUMINUM COMPANY OF AMERICA, PITTSBURGH

AS A PART of their investigation of arch dams, the engineers of the Aluminum Company of America have built a model of an existing dam, with particular attention to the conditions of similarity that must obtain to secure not only scalar reproduction of the prototype, but a model in the engineering sense of the word. Some of the supplementary researches undertaken, characteristics of the completed model, and the methods and instruments used for the tests, are here described. The model is made of a rubber litharge compound having the same specific gravity as the concrete in the dam, and water is used for the loading material. It is planned to compare the behavior of the model with that of the full-sized dam, on which elaborate measurements have been made under varying conditions of temperature and load. This description of methods used in constructing the model and results obtained from preliminary tests, is in the nature of a progress report on the studies being carried out on the general subject of arch dams.

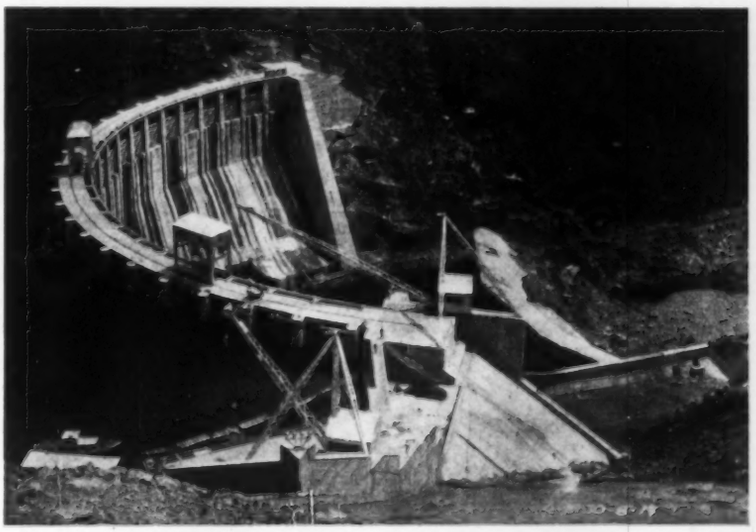
ADVANCES in structural engineering during the last few decades are well exemplified by the better understanding of statically indeterminate structures which now prevails, and by the successful utilization of such structures in up-to-date designs. A proper understanding of statically indeterminate structures necessitates a knowledge of the principles underlying the theory of elasticity. Some of these principles have been known for a great many years. Nearly all the basic theoretical work was done by early experimenters as pure scientific speculation, probably without thought of its possible usefulness. Methods of practical design were developed much later—most of them in our own time—partly as a result of the use of concrete for structures.

Most of the accepted designs are based on definite assumptions insuring a close agreement between the theoretical and the actual behavior of the structure. The arch dam is one of the very few major structures, the design of which may be based on several radically different assumptions.

Arch dams have been designed assuming that all the load is taken by arch action, neglecting gravity action entirely; and they have also been designed on the assumption that the load is taken partly by arch and partly by gravity action. Since these designs result in dams materially different in shape and computed stresses, it is obvious that one of these assumptions, or both partially, are incorrect. It seems reasonable that a certain relationship should exist between the shape of the dam and the topography of the site, but this relationship has not been properly brought out in any of the design methods heretofore accepted.

Everyone who has designed statically indeterminate structures realizes that the work of evaluating deflections and stresses is so complicated, requiring so much time and such a large number of trials, that in many cases a solution is only possible after measures have been taken to simplify the procedure. This difficulty has led to a number of short cuts in design methods, many of which are very unsatisfactory because of the misleading results obtained.

Abroad, particularly in Germany, much labor has been expended in classifying the different statically indeterminate structures and in developing tables and formulas that will enable analyses to be made quickly and with the least possible effort. Such classification involves a simplification of these structures and can apply only to a limited number of comparatively simple cases. In solving more complicated cases, these tables and formulas are of little use. In the United States, under the leadership of George E. Beggs, M. Am. Soc. C.E., Professor of Civil Engineering at Princeton University, the tendency of recent years has been to use investigations on models for the solution of complicated structural problems.



CALDERWOOD ARCH DAM ON THE LITTLE TENNESSEE RIVER
First Filled in April 1930

The Aluminum Company of America first became interested in arch dams in 1925 in connection with some of its developments. In the beginning it was realized that, for designs based on purely theoretical considerations, quite a difference may be expected between the theoretical and the actual behavior of a dam, and that the information

necessary to start the investigation could best be obtained from an accurate test on a commercial arch dam of appreciable height. The construction of the Calderwood Dam, which was contemplated at the time, provided the opportunity for making such tests, and the necessary testing facilities were therefore incorporated in that structure.

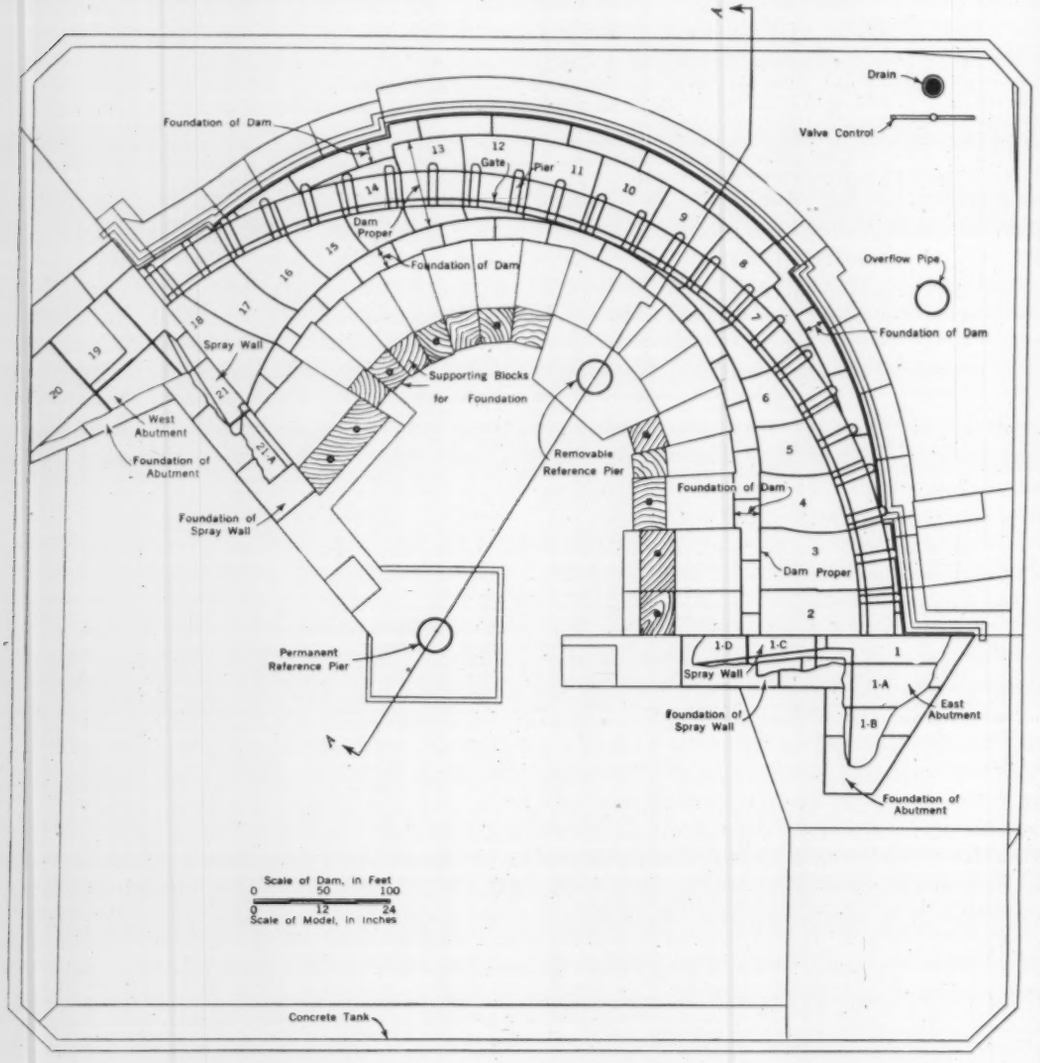


FIG. 1. PLAN OF TESTING BASIN AND MODEL OF THE CALDERWOOD DAM

IMPROVED THEORY OF ARCH DAM DESIGN IS DEVELOPED

In the meantime a new theory of arch dam design was developed, which appeared to be such an improvement over those formerly used that it was considered desirable to check the new theory by means of models. In the past, the principal objection to the use of models has sprung from doubt as to the relative behavior of the model and the prototype. In an attempt to eliminate this uncertainty the following test program was adopted:

1. Careful tests to determine the strains and deflections in Calderwood Dam.
2. Comparison of the actual strains and deflections in Calderwood Dam with those computed mathematically.
3. Building and testing of an engineering model of Calderwood Dam to determine strains and deflections due to the application of load; a comparison of the results obtained from the model with the results given by the prototype; and modification of the model during tests to make its deflections and strains correspond as closely as possible with those existing in the dam itself.
4. Designing, building, and testing a model of an arch dam of improved design adapted to the Calderwood site. When the results of tests on this second model are available they are to be translated into terms of its theoretical prototype, so that the advantages and disadvantages of the improved design can be shown. Conclusions may then be reached which will make possible further improvements in the design of arch dams.

The Calderwood arch dam on the Little Tennessee River is about 200 ft. high and 737 ft. long at the crest, between abutments. Measurements made on it emphasized the importance of construction joints and foundation deformations in the behavior of such a dam and influenced considerably the design of the models. The scale for both models will be the same, 1:50. The model of the present Calderwood Dam has been built, and is now being tested.

SIMILARITY CONDITIONS TO BE OBSERVED

In building an engineering model, the object is to create a structure whose behavior under different conditions will correspond to that of its prototype. This means that a certain definite relationship must exist between the behavior of the model and its prototype. This relationship, which must necessarily be rather simple, is secured by fulfillment of the similarity conditions. Scalar representation is only one of the factors in making a model. A number of others are to be considered, some of which are probably of no less importance. The more important are as follows:

1. The ratio of the specific gravity of the loading liquid and the material of the dam should be the same in the model as in the prototype.
2. The construction joints of the prototype should be represented in the model.

3. Foundation and abutment conditions of the prototype should be properly represented in the model.

For a more detailed discussion of the similarity conditions pertinent to an arch dam model, reference is made to the discussion by A. V. Karpov, "Theory of Similarity and Models," in the February 1931 issue of the PROCEEDINGS of the Society, page 359.

In general, it can be assumed that the model which most closely approaches the theoretical requirements will give the most reliable results. The practical value of the results of tests on a theoretically incorrect model depends to a very large extent on the size of the dam. For a very thin dam of moderate height, even a crude model that is only a scalar representation of the prototype and neglects other similarity requirements may give satisfactory results. But for a higher dam or for one with a thick cross section, such a model may give misleading results, and no simple comparison will be possible between its behavior and that of its prototype. Considerable difficulty is encountered in building a model of an arch dam that will fulfill all the similarity conditions. It is inevitable that there should be some discrepancy between the actual model and the strictly theoretical principles on which its design is based.

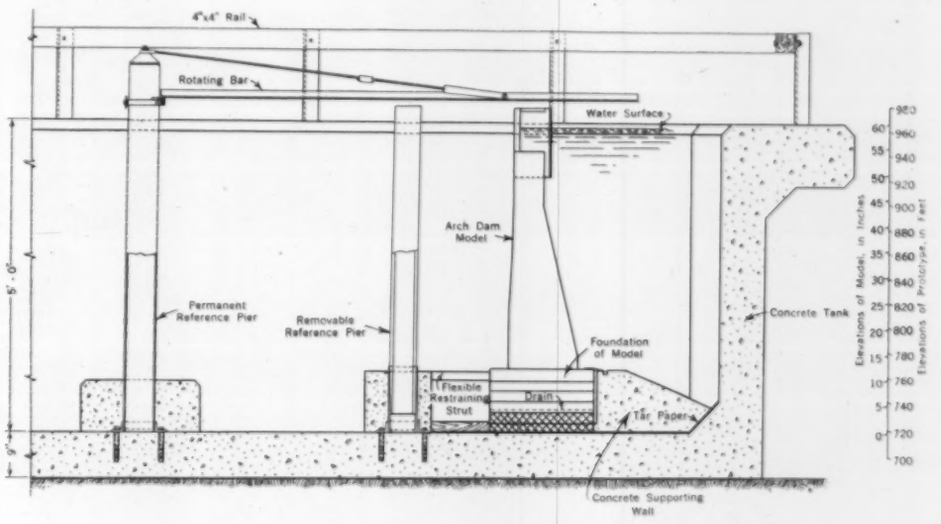


FIG. 2. SECTION AA OF THE MODEL OF THE CALDERWOOD DAM

MODEL OF CALDERWOOD FOUNDATION SITE, SHOWING SIMPLIFIED CONTOURS
Scale Indicated by Toy Soldiers

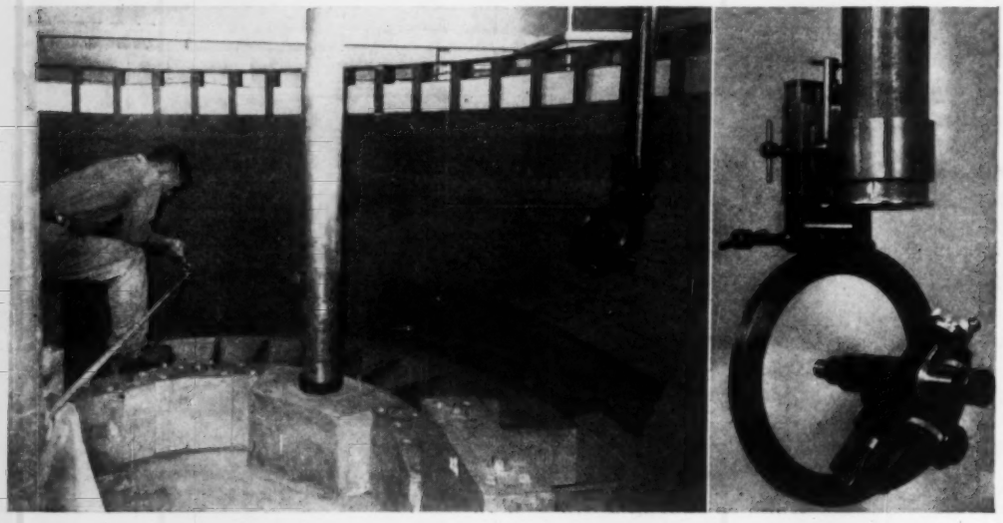
The determination of the properties of the material of the prototype was of importance. So far as the concrete used in the Calderwood Dam is concerned, it was deemed inadvisable to rely on the results of the tests of standard size cylinders. Accordingly, considerably larger concrete cylinders 24 in. in diameter and 4 ft. high were made of the same material as that in the dam and at the same time, and were similarly placed and cured. They were tested in cooperation with, and at the laboratory of, the U.S. Bureau of Standards and showed a modulus of elasticity of 3,800,000 lb. per sq. in., a Poisson's ratio of 0.15, and a specific gravity of 2.4. The elastic properties of the rock ledges at the dam site were determined by the testing of diamond drill cores 2 in. in diameter. Tests were also made to determine the amount of tension that could be carried across the construction joints of the dam.

MATERIAL OF MODEL AND LOADING FLUID DETERMINED

The next and probably the greatest difficulty was to find a proper material for the model. The necessity of having the ratio of the specific gravities of the loading fluid and the material in the dam the same in the model as in the prototype precludes the use of mercury as a loading fluid. If mercury were used, the specific gravity of the model material would have to be equal to the specific gravity of the concrete in the dam multiplied by the specific gravity of mercury, or $2.4 \times 13.16 = 32.84$. Since no known material has such a high specific gravity, a lighter loading fluid must be used. Water appears to be most practical for this purpose, and hence the specific gravity of the material of the model should be the same as that of the concrete in the prototype.

Concrete, which was first considered as a material for the model, was rejected for two reasons—in the first place, because of the difficulty of properly representing foundation and abutment conditions. Also, since

the ratio of the deflections of a model to those of its prototype is equal to the square of the scale, the deflections in a concrete model to the scale of 1:50 would be very small, 1:2,500.



DOWNSTREAM FACE OF THE COMPLETED MODEL
Deflection Measuring Rod, Strain Measuring Microscope, and Removable Reference Pier. Microscope in Inset

It was felt that the study of such a model would be of little value. To disclose the influence and relative importance of the various factors on which the behavior of the dam depends, it seemed necessary to have a much more sensitive model in so far as deflections were concerned. It was decided, therefore, to use in the model a material having the same specific gravity as concrete, that is, 2.4, but with a much lower modulus of elasticity, so as to increase the deflections.

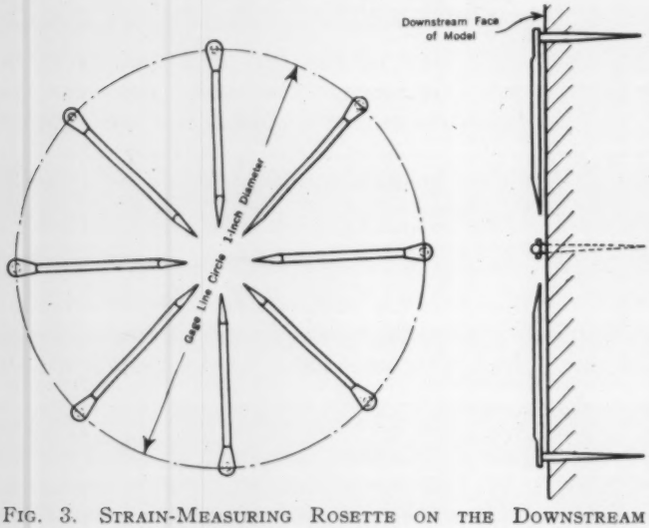


FIG. 3. STRAIN-MEASURING ROSETTE ON THE DOWNSTREAM FACE OF THE MODEL

Such a substance was not available and much research was necessary before a suitable material was finally developed. This material, a rather remarkable compound of rubber and litharge, was subjected to extensive tests in the Research Laboratories of the Aluminum Company of America, to determine its physical characteristics. These tests are described in a paper by R. L. Templin and R. G. Sturm, entitled "Methods for Determining the Physical Properties of Certain Rubber Compounds at Low Stresses," in the *Proceedings* of the American Society for Testing Materials, Vol. 31, 1931. It has an average modulus of elasticity of about 500 lb per sq. in., a Poisson's ratio approaching 0.50, and a specific gravity of 2.40. It satisfies practically all the similarity conditions, except for the values of Poisson's ratio.

ACTUAL CONDITIONS SIMULATED

In order to meet the similarity conditions imposed by the presence of construction joints, the model is a structural replica of the actual dam in that it is made up of separate blocks like those in the prototype, with very pronounced vertical, and less pronounced horizontal, joints.

In designing a model, the proper representation of the foundation presents a problem. The behavior of the prototype is greatly influenced by the deformations of its foundations, but data concerning these deformations are very limited. Theoretical investigations on this subject, of a type suitable for practical application, were made by Fredrik Vogt, M. Am. Soc. C.E., and described in a paper entitled "Ueber die Berechnung der Fundamentdeformation" (Oslo, Norway, 1925). However, no experimental proof of his theories is known to us. This lack of data makes it necessary to include foundation deformation tests among the model experiments. To make such tests possible the foundations of the model were designed so that such deflections can be controlled over a wide range.

Since the success of a model study depends largely upon trained observers and up-to-date equipment, it was decided to conduct the tests in the Aluminum Re-

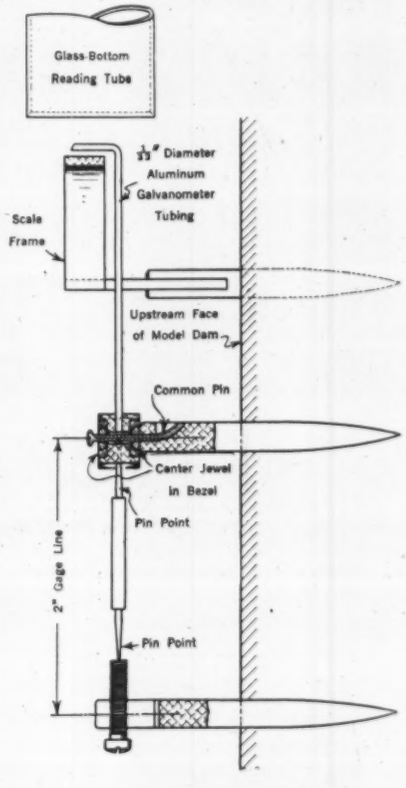


FIG. 4. STRAIN MEASURING DEVICE ON THE UPSTREAM FACE OF THE MODEL

search Laboratories at New Kensington, Pa. The structure which houses the model is provided with double doors, and its walls and ceiling are insulated with celotex. A uniform temperature may be maintained during tests by thermostatic control of gas and electric heaters. Since no refrigerating facilities are provided, it is necessary, in order to maintain a constant temperature in the testing room, to keep it somewhat warmer than the average 24-hour temperature. The model is located in a reinforced concrete testing basin 5 ft. deep and 14 ft. 6 in. square, designed so that deflections in the floor and the sides of the basin are reduced to a minimum. The basin is provided with the necessary water and drainage connections, which permit the filling and emptying of the section upstream from the model. Before entering the basin the water passes through an electric heater so that it can be brought to the desired temperature.

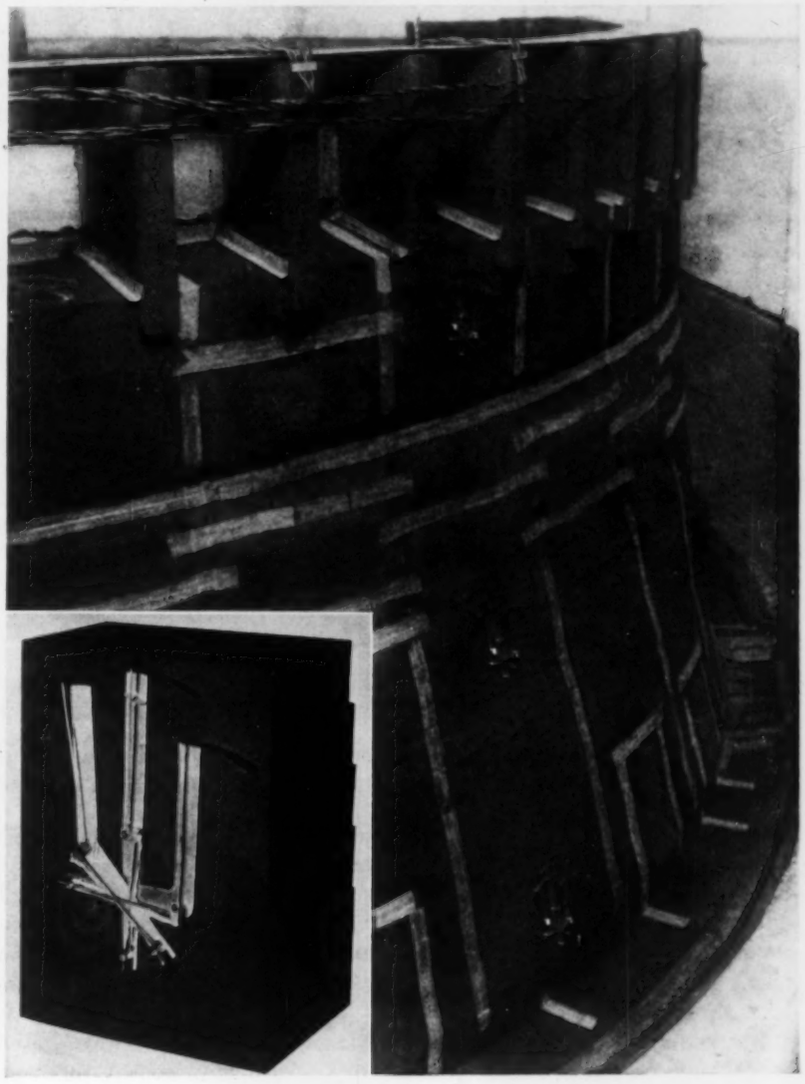
PERMANENT AND REMOVABLE REFERENCE PIERS PROVIDED

Necessary facilities inside the basin include concrete walls to support the foundations, and supports for the reference piers. The two reference piers, one permanent and the other removable, are shown in Figs. 1 and 2. In location, the permanent pier corresponds to the reference pier used to measure deflections in the dam itself. A rotating arm at the top of the permanent pier, shown in Fig. 2, is used to check the elevations on the model. The general arrangement of the basin and the model is shown in Fig. 1, the model being outlined by heavy lines. This chart shows clearly to what extent the east and west abutments and the spray walls are represented and how important a part is played by the foundations.

Since the dam is a structure with definite dimensions, the model was reproduced exactly to scale. On the other hand, the rock ledge on which the dam rests, being indefinitely large, could not be represented to scale. Hence, in order to represent properly the action of bedrock, the foundations were built of rubber-compound blocks supported on a hardfiller. The deflections of the model's foundations can be regulated and adjusted by changing the size and location of the struts shown in cross section in Fig. 2, for which pipe jacks were afterward substituted. If such regulation should prove insufficient, the size of the foundations can be changed by substituting a hard filler for a part of the rubber compound, or vice versa. The possible deformations of the hard filler and supporting concrete are so small as compared with those of the rubber compound that they can be neglected.

In order to make the deflections of the foundations independent of hydrostatic pressure, a rubber strip was cemented to the top of the foundations, to seal the gap between them and the adjoining concrete wall. Openings are provided to drain any leakage from the space behind the foundations.

The horizontal joints of the foundations are cemented together so that in a vertical direction the foundations



THE UPSTREAM FACE OF THE MODEL
With Detail and Setting of Upstream Strain-Measuring Devices

act as a solid block. The vertical foundation joints were not cemented, in order to facilitate handling and building. However, in order to insure uniform action, care was taken to fit the blocks together as closely as possible and to stagger the joints with respect to the vertical joints in the model.

FOUNDATION OF MODEL BUILT UP IN STEPS

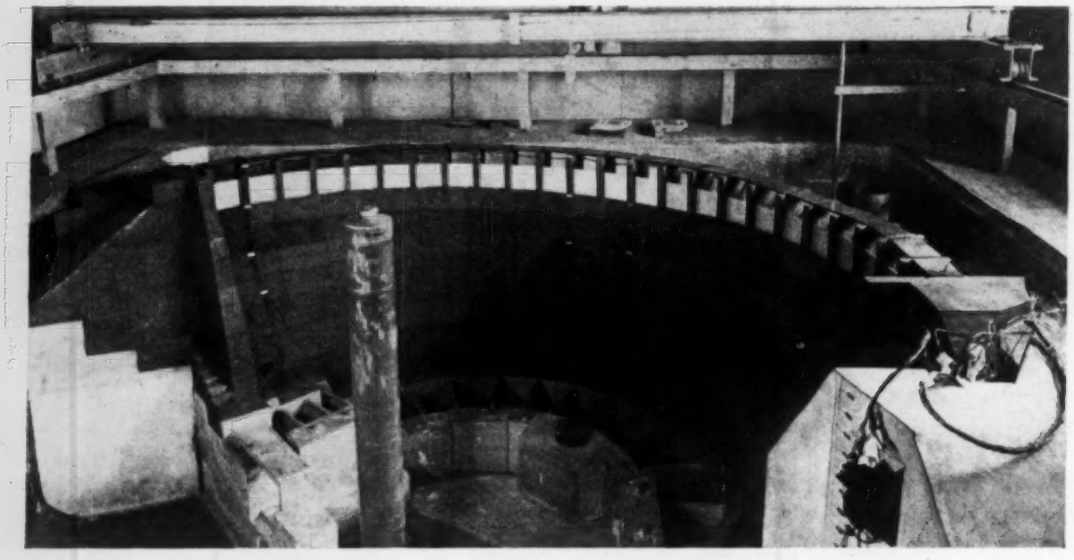
In the model, the topography of the dam site proper was simplified by building up the foundations in 5-ft. steps, except for the very steep parts, where 10-ft. steps were used. The area between each two consecutive contours is therefore a flat horizontal surface. The bottom of the model fits closely into the steps in the foundations, but is not cemented to them. The material for the model was delivered in slabs 1 in. thick, which were cut on a band saw and the exact shape checked, by the use of sheet aluminum templates. The

slabs were then joined together by means of a special rubber cement.

Illustrations of the model during construction show the vertical and horizontal construction, joints and the wooden struts which restrain the deflection of its foundations. Very thin rubber bands cemented over the joints seal them against the entrance of water.

SPECIAL MEASURING INSTRUMENTS DEVELOPED

In building the model, provisions were made for measuring strain, deflections, and temperature under different loading conditions. Since reliable conclusions cannot be based on single strain measurements obtained only on the downstream face, the model is built so that such measurements can also be made on the upstream face. At each station the strains can be measured in at least three directions.



THE COMPLETED MODEL, WITH PERMANENT REFERENCE PIER
Overhead Crane for Microscope and Wiring for Thermocouples

Strain measurements on the downstream face of the model can be made rather simply by the use of wire spurs. A set of eight spurs is placed at each strain measuring station, as indicated in Fig. 3. The distance between the ends of each pair of spurs is measured by a traveling precision microscope, which is mounted in a ring. The mounting is such that the center line of the microscope, irrespective of its position, will always travel on the diameter of the mounting ring, making it possible to measure the distance between the ends of two spurs located at any angle. The mounting ring can be turned or tilted in any direction so that the line of travel of the microscope can be made parallel to the face of the model. The whole attachement is mounted on a vertical pipe carried by an overhead crane, so that every downstream station is accessible. Changes in distance between the points of the spurs give directly the changes in length of the corresponding gage lines.

DEFLECTIONS MEASURED TO REFERENCE PIER

At the stations on the downstream face, deflections are determined by measuring the distances between these stations and the reference piers. One end of the measuring rod is inserted in one of a number of holes drilled in the reference pier, and the distance is measured to a corresponding special tack on the downstream face of the model, the distance being read on a dial attached to the rod. The temperature of the model is determined by means of buried thermocouples.

The device shown in Fig. 4 is used for making strain measurements on the upstream face at stations that will be submerged during loading periods. Changes in length of the gage line can be read directly on the scale. At each upstream station a set of three of such measuring devices is arranged as illustrated. The scales are read by observing them through a glass-bottomed pipe. The temperature of the model is determined by means of buried thermocouples.

PRELIMINARY CONCLUSIONS

Tests now under way show the model to be very sensitive; changes in water elevation of one-eighth of an inch result in deflections of such magnitude that they can be easily measured. This fact makes it necessary to pay more attention to a number of factors that in the past have often been neglected. In order to obtain close similarity in behavior between the model and its prototype, it has been necessary to make a number of adjustments at the foundations, abutments, and construction joints.

A few of the more important preliminary conclusions based on the model study may be summarized as follows:

1. Foundation conditions seem to be of paramount importance; a design that assumes non-yielding foundations and abutments appears to be inadequate.
2. Vertical construction joints influence considerably the magnitude of the maximum stresses in the dam.
3. Any increase in the thickness of the horizontal arch rings from the crown toward the abutments does not seem to be justified since it does not relieve the stresses, and under certain circumstances it may even lead to the piling up of stresses at some points in the dam.

This investigation of arch dams was initiated by E. S. Fickes, M. Am. Soc. C.E., Senior Vice-President and Chief Engineer of the Aluminum Company, in an endeavor to put the design of such dams on a more scientific basis. The investigation is now being carried out by the writers under the general direction of James W. Rickey, and J. P. Growdon, Members Am. Soc. C.E., respectively, Chief Hydraulic Engineer, and Assistant Chief Hydraulic Engineer of the company. We wish to acknowledge the assistance of R. G. Sturm, Assoc. M. Am. Soc. C.E.; H. N. Hill, Jun. Am. Soc. C.E.; and P. B. Ramsey, in the preparation of this paper.

The Basic Elevation Datum

Ironing Out the Non-Periodic and Cyclic Fluctuations of Sea Level

By H. A. Marmer

Member American Society of Civil Engineers

Assistant Chief, Division of Tides and Currents, U.S. Coast and Geodetic Survey, Washington, D.C.

THERE is scarcely an engineering job which does not involve the determination of elevations; and much care and expense are often devoted to carrying control elevations to a job with precision. The datum to which engineers generally refer elevations is sea level, but they seldom concern themselves with the necessity of establishing the true value of that datum. In this article, Mr. Marmer explains that sea level may fluctuate as much as a foot from month to month, and several tenths of a foot from year to year, even when the hourly tidal variations are averaged. To obtain a primary sea level determination, the average of hourly readings over a 19-year cycle is necessary. However, readings over a period of a month, when corrected by simultaneous elevations at a suitable station, will give results that are accurate within one-tenth of a foot. Engineers concerned with work that depends upon the sea will find valuable information in this authoritative article.

IN measuring land heights or sea depths, the basic elevation datum is mean sea level. This is true not only in engineering but in all technical and scientific work. It happens, however, that it falls to the lot of the engineer—particularly the tidal engineer—to determine and establish this basic elevation datum.

This universal use of mean sea level as the primary datum results from the fact that it possesses a number of advantages. Specifically, the use of mean sea level insures simplicity of definition, accuracy of determination, readiness of correlation, and certainty of recovery, even though all benchmark connections be lost. The engineer who attempts to correlate surveys made on different datums, or finds it necessary to recover some arbitrary datum used in a previous survey, will appreciate particularly the two last-mentioned advantages in making use of mean sea level for the datum.

Since mean sea level is a familiar and almost self-explanatory term, there is a deceptive implication that it can be easily determined. For rough estimates this is true; but when it becomes necessary to make a precise determination, difficulties appear. For any point along the coast, mean sea level may be defined very simply as the mean level of the sea at that point. To obtain this level, the height of the sea at the desired point should be measured at frequent intervals and the average height determined. The question that immediately arises is, for how long a period must the height of sea level be averaged to secure an accurate determination? This question can best be answered by a consideration of the results derived from observations covering different periods of time.

In this connection careful distinction must be made between the terms "sea level" and "mean sea level." Sea level properly refers to the level of the sea at a particular instant. In the same way, daily, monthly, or yearly sea level refers to the level of the sea for a day, a month, or a year. Mean sea level, however, refers to the mean level of the sea as determined from observations extending over a considerable period.

The level of the sea is at all times disturbed by waves and tides. However, disturbing wave effects are easily eliminated in various ways; and since the tidal day has a length approximately equal to that of the ordinary day, the effect of the tide may be largely eliminated by measuring the height of the sea at frequent intervals during a day and averaging these heights. As a rule, sea level for any day is derived by taking the height of the sea at the beginning of each hour and averaging the 24 observations.

VARIATIONS OF SEA LEVEL

It is clear that sea level as determined from one day of observations may differ considerably from that of another day, because of variations in meteorological conditions. It is a matter of common knowledge, for example, that strong winds or wide variations in barometric pressure bring about decided changes in the level of the sea. But even with uniform weather conditions, the sea level exhibits daily changes.

This fact is indicated in Fig. 1, which shows diagrammatically the daily height of sea level in New York Harbor during the month of May 1930, when weather conditions were relatively uniform. The open circles indicate the height of sea level for each day of this month as determined by averaging the 24 measurements —one for each hour throughout the day—which practically eliminated the effect of the rise and fall of the tides. It is seen that, for this month, the daily variation of sea level was from less than one-tenth foot to more than one-half foot. Moreover, the difference between the lowest and highest daily sea level (on May 3 and May 15, respectively) was $1^1/_2$ ft.

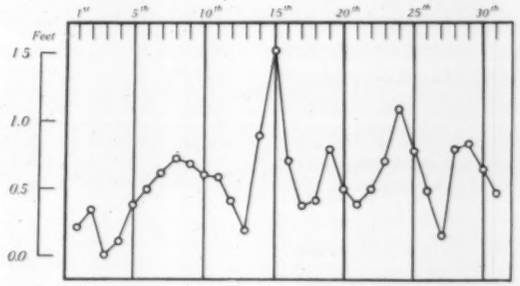


FIG. 1. DAILY SEA LEVEL, NEW YORK HARBOR, MAY 1930

Each Point Is the Average of 24 Hourly Readings

During periods of heavy winds or of wide changes in barometric pressure, the variation in sea level from day to day will obviously be much greater. For example, during March 1930, two months earlier than the period represented in Fig. 1, the differences in sea level for consecutive days were as much as a foot or more, while

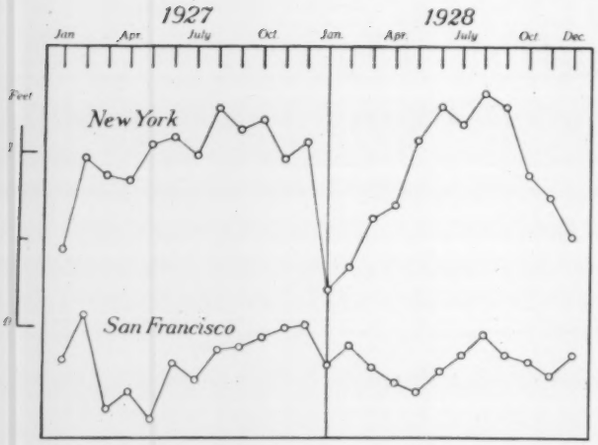


FIG. 2. MONTHLY SEA LEVEL, NEW YORK AND SAN FRANCISCO 1927–1928

the difference between the highest and lowest values for the month was 3 ft.

Since a day is a relatively short period of time, it is not surprising that the value of sea level based on the observations of one day should vary considerably from that of another day, and hence from mean sea level. In this connection, it is necessary to discover whether there are any changes in sea level from month to month. In Fig. 2 are shown the monthly heights of sea level in New York Harbor and in San Francisco Bay for a two-year period. It is at once evident that sea level also varies considerably from month to month, and that within any one year this variation may amount to as much as one foot.

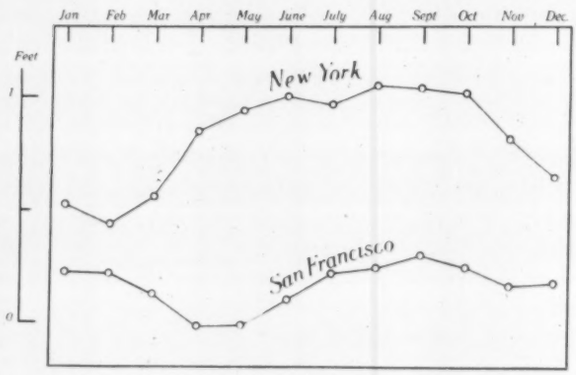


FIG. 3. MEAN SEASONAL VARIATION IN SEA LEVEL, NEW YORK AND SAN FRANCISCO
Curves Derived from 30 Years of Observations

It is obvious that the variation of sea level from day to day is primarily non-periodic, as it results from changes in wind and weather. In the variation of sea level from month to month, however, a large element of periodicity appears. In New York Harbor, for example, it is seen that as a rule sea level is high in the summer and low in the winter. In the same way, the sea level in San Francisco Bay is generally low in the spring and high in the late summer and autumn months. In other words, sea level exhibits a periodic seasonal variation.

This seasonal variation will differ from year to year, for weather conditions do not repeat themselves exactly. However, by averaging the monthly heights of sea level for a number of years, accidental or non-periodic variations will be eliminated and the mean seasonal variation will appear in its periodic form. The curves of this seasonal variation in sea level in New York Harbor and in San Francisco Bay, derived from 30 years of observations, are indicated in Fig. 3. On the average, sea level in New York Harbor is lowest in February, increases gradually to June, declines slightly to a secondary minimum in July, and then increases to a maximum in September. For San Francisco Bay the seasonal variation is quite different, as the minima come in April and November, and the maxima in January and September.

THE VARIATION IN ANY ONE REGION

That the seasonal variation of sea level in New York Harbor should differ from that in San Francisco Bay is not surprising, since the two places are situated on different oceans and are thousands of miles apart. But it is to be expected that along an open coast, or in a large arm of the sea, the seasonal variation in sea level at any point would be representative of conditions in the vicinity. This is borne out by observations. In Fig. 4, are shown the curves of seasonal variation in sea level for five stations along the Atlantic Coast from Maine to Florida. At each point indicated this curve has distinctive local characteristics. But for places near each other the variation is much the same, as is illustrated by the curves for Fort Hamilton and Atlantic City. Fort Hamilton is situated in the protected waters of the Lower Bay in New York Harbor, while Atlantic City, nearly 100 miles to the south, faces the open Atlantic on the coast of New Jersey. Nevertheless the two curves resemble each other closely.

A glance at Fig. 4 shows that along the Atlantic Coast of the United States the range of mean seasonal variation of sea level increases from north to south. At Portland the maximum range within an average year is barely a quarter of a foot; at Fort Hamilton and at Atlantic City it is a little over half a foot; at Baltimore it is more than three-quarters of a foot; and at Fernandina it is exactly one foot. While the curve at each place has definite local characteristics, it may

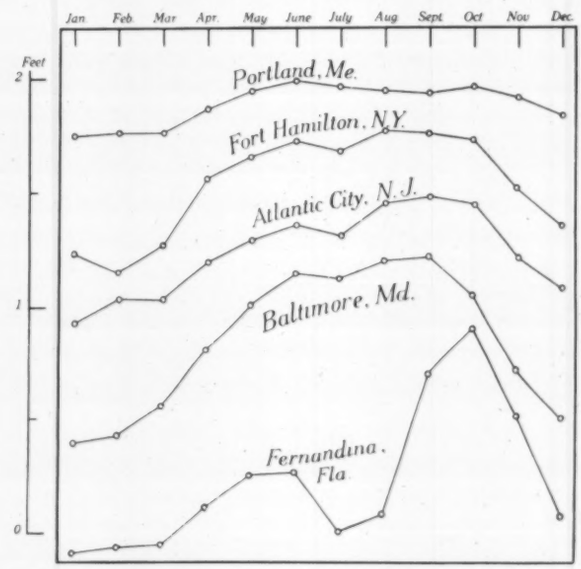


FIG. 4. MEAN SEASONAL VARIATION IN SEA LEVEL AT POINTS ALONG THE ATLANTIC COAST

be said in general that the sea level on the Atlantic Coast is lowest in the winter and highest in the fall.

In Fig. 5 are shown the curves of mean seasonal variation in sea level on the Pacific Coast. Here again, each station shows distinctive local features. Thus at Seattle a low-level phase is maintained from April to October, while at San Francisco and San Diego the high-level phase culminates in October.

In view of the fact that sea level determined from one month of observations may differ from that obtained in another month by half a foot or more, and may be further affected by non-periodic variations in wind and weather, it is necessary, where sea level is to be made the basis of precise measurements, to use observations covering a longer period than a month. A year suggests itself as a suitable length of time for the averaging of such measurements. It remains, therefore, to consider whether there are any variations in sea level from year to year.

In Fig. 6, are shown the yearly values of sea level in New York Harbor and San Francisco Bay for the 25-year period from 1899 to 1923. It is immediately apparent that sea level also varies from year to year. However, this variation is rather small, as is evidenced by the fact that the scale to which the diagram is plotted must make use of a unit as small as one-tenth of a foot. Generally the difference in sea level from one year to the next is less than this amount, although occasionally it may be as much as a quarter of a foot, or even more, as exemplified by the findings for the years 1900 and 1901 in New York Harbor, and by those for 1913 and 1914 in San Francisco Bay.

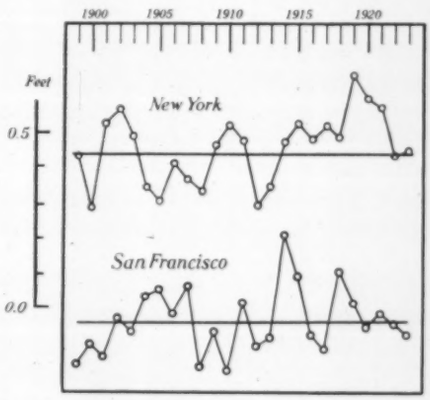


FIG. 6. YEARLY HEIGHTS OF SEA LEVEL IN NEW YORK HARBOR AND SAN FRANCISCO BAY 1899–1923

In Fig. 6, the two horizontal lines represent the average level of the sea at each of the stations for a 25-year period, and these lines may be taken as representing mean sea level. The variation from year to year is thus clearly shown. For New York Harbor, the curve indicates a variation in sea level with a period of about four years, and another with a period of about nine years. In San Francisco Bay there appears to be a variation with a period of slightly over two years. It may be noted that no simple relation appears to exist between the sea level in New York Harbor and that in San Francisco Bay.

Although there are occasional variations, it appears that if in any one year sea level is high, or low, at one point along a given coast, it is also high, or low, along the entire coast. In Fig. 7 are indicated the yearly heights of sea level for several stations along the Atlantic Coast. It is seen that, for a period of a year, high sea level at one point generally means high sea level all along the coast; and the same is true for a year of low sea level. These conclusions are found to apply in a similar manner to stations located along the Pacific Coast.

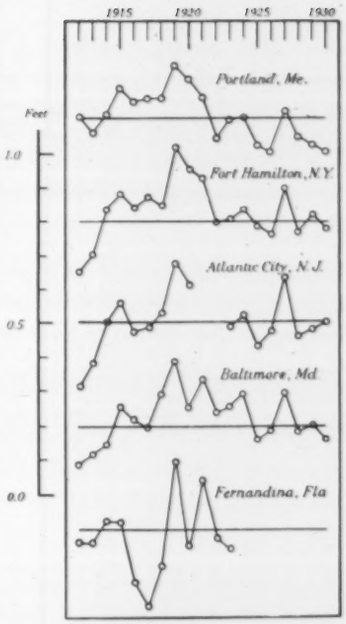


FIG. 7. YEARLY HEIGHTS OF SEA LEVEL FOR FIVE STATIONS ON THE ATLANTIC COAST

Because of the variation in sea level from day to day, from month to month, and from year to year, the accurate determination of mean sea level presents two problems to the engineer. The first is, how long a series of tide observations is required to give an accurate determination of mean sea level; and the second, how can sea level derived from a short series of observations be corrected to a mean value?

In tidal observations, a period of 19 years is taken as constituting a full tidal range, for during this time the more important of the tidal variations will have gone through complete cycles. Hence sea level derived from 19 years of observations is generally considered to constitute a primary determination of mean sea level and to give this datum accurately. From two different series of observations over 19-year periods, it may be expected to derive values for mean sea level that will not differ by more than 0.02 or 0.03 ft. For practical purposes, however, 19 years is a very considerable period of time. Moreover, an examination of the yearly heights of sea level has disclosed the existence of a cyclic variation with a period of about 9 years. So, for practical purposes, sea level based on 9 years of observations may also be taken as constituting a primary determination of mean sea level, and as giving this datum with sufficient accuracy for all ordinary needs.

If even 9 years of observations were required for an

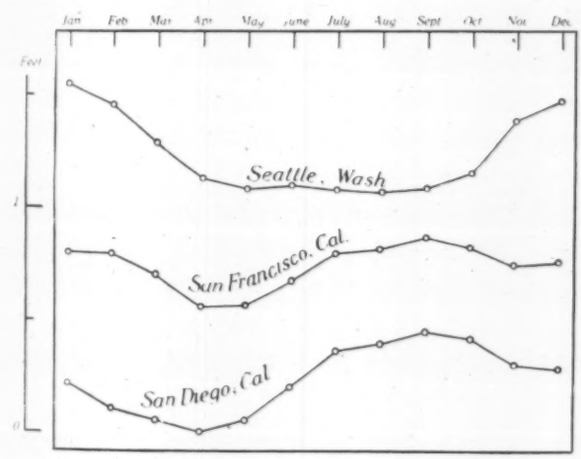


FIG. 5. MEAN SEASONAL VARIATION IN SEA LEVEL AT POINTS ALONG THE PACIFIC COAST

accurate determination of mean sea level at all points where such a datum is desired, the task would be a very formidable one. Fortunately it is possible to reduce this period by taking advantage of the fact that sea level varies in much the same way over relatively large areas. It thus becomes possible to make secondary determinations of mean sea level with considerable accuracy, from observations covering periods of a month or more. The procedure involves the comparison of observations at the station for which mean sea level is desired with observations taken simultaneously at some suitable station at which a long series has been obtained.

USE OF A CORRECTION FACTOR

An example will make this clear. Suppose that in 1913 it had been desired to determine with some precision the plane of mean sea level at Atlantic City during the month of March. After an automatic tide gage had been established and had functioned for that month, sea level would have been determined by averaging the hourly heights of the tide. This would then have been related to some bench mark on shore which, for the sake of illustration, may be assumed to have been 10.25 ft. above the sea level for that month.

On examining the tide record at Fort Hamilton, it is found that for March 1913, sea level was 0.72 ft. below its mean value for 19 years. Since Atlantic City lies close enough to Fort Hamilton to be subject to similar variations in sea level, it may be assumed that the sea level at Atlantic City for that month was likewise 0.72 ft. below the mean value. Hence the bench mark at Atlantic City would be taken as 10.25 − 0.72 = 9.53 ft. above mean sea level.

Had the observations been made in August 1919, sea level for the month would have been found to be 9.05 ft. below that same bench mark, or a difference of 1.20 ft. from that in March 1913. If, however, this value is again compared with simultaneous observations at Fort Hamilton a correction of 0.52 ft. is indicated, so that from this month mean sea level would be determined as 9.57 ft. below the bench mark. In other words, where the two monthly values of sea level differed by 1.20 ft., the method of comparison of simultaneous observations brought the two determinations of mean sea level within 0.04 ft. of each other.

CLOSE APPROXIMATION POSSIBLE

In this particular case, it is possible to check the closeness with which these values for mean sea level approach the precise value of this datum, as observations covering a period of 16 years are available at Atlantic City. According to these observations, mean sea level lies 9.53 ft. below the bench mark used in this case. The sea level derived from the March 1913 observations is thus 0.72 ft. below the exact value, while for August 1919 it is 0.48 ft. above it. However, when these averages are corrected by comparison with the observations at Fort Hamilton, one agrees exactly with the precise value, and the other differs from it by only 0.04 ft.

March 1913 and August 1919 were chosen for comparison because the sea levels for these months represent, respectively, the lowest and highest monthly levels for the series of observations at Atlantic City. In general, it may be taken that a month of observations at any place, when corrected by simultaneous observations at some suitable station, will give the mean sea level within 0.1 ft. Observations extending over a year will give it within 0.05 ft., and over 4 years, within 0.02 ft.

This giant "nutcracker" is one of the cable supports of the Mid-Hudson Bridge, between Poughkeepsie and Highland, N.Y. The two cables of the bridge are 16¾ in. in diameter. A photograph and a brief description of this structure are to be found on page 325 of the January 1931 issue.

Traffic Surveys to Solve Highway Problems

Present Tendencies in Anticipating and Providing for Future Conditions

By Bruce D. Greenshields

Associate Member American Society of Civil Engineers

Professor of Engineering Science, Denison University, Granville, Ohio

WHETHER they would or not, engineers are obliged to forecast the future demands on American highway systems. Only so can the work of the present be coordinated with the needs that may be expected to arise. Of all the tools for such estimate the traffic survey is one of the most useful. What it is and how it may be applied to engineering problems are here outlined. Specifically, Professor Greenshields is concerned with the questions of when, where, and how to build roads for the future, and with the conflict between economy and political expediency. Numerous examples from various states illustrate the application of the principles explained here.

It was about 1850 that the development of the railroad put an end to the early importance of highway transportation. Only within the past 25 years, as a result of the coming of the automobile, have we seen the reemergence of the highway to a position of major importance in the American transportation scheme. Our annual highway bill has reached $1,500,000,000, about $6\frac{1}{2}$ times what it was in 1917, but during the same time motor vehicle registration has reached 26,500,000, an increase of 53 times that of 1917. Due to the rapidly growing traffic demands and large expenditures, new conceptions and new methods in highway construction and planning are necessarily coming to the fore.

We recall the early period as one of local control, characterized by inefficient construction methods, inadequate types of construction, and failure to develop connected systems, all of which meant a waste of public funds. The present period, on the other hand, is marked by a new highway improvement policy involving the development of national, state, and regional highway systems based on a scientific analysis of traffic and engineering facts.

These facts are secured by means of the transportation survey, that is, an investigation designed to portray traffic conditions on a system of highways over at least a 12-month period, so as to show peak and seasonal variations. It includes the gathering and analysis of all data—physical and financial—which enter into the planning of a highway system. In carrying out such a survey, a state is divided into districts or areas, homogeneous in character; and the traffic flow in each area is secured by means of traffic counts taken at a minimum number of stations.

In general, an analysis of the data gathered in this way will show:

1. Population and motor vehicle registration trends in each area
2. Amount, weight, and characteristics of passenger and cargo traffic over at least a year's time, so as to bring out peak and seasonal variations
3. Origin and destination of individual motor vehicles
4. Condition of existing highways, including type of surface and width
5. Relative use of roads by urban and rural vehicles
6. Possible future effect of the unusual development of industrial or natural resources
7. Sources and amounts of highway income

By intelligent use of these data it is possible to diagnose such highway problems as: (1) where to build roads; (2) when to build roads; (3) how to build roads; and (4) how to justify expenditures or methods of procedure in the face of political pressure or change.

For the sake of simplicity, each of these problems will be considered separately, in the order given, but it should be understood that no part of the study can be made intelligently without an understanding of the problem as a whole.

WHERE TO BUILD ROADS

In order to know where to build roads best to serve traffic, it is necessary not only to learn the present distribution of motor vehicle traffic as to type and volume, but also to estimate future traffic, for that is what the road is constructed to serve. Transport surveys that have been completed show certain general underlying principles that can be applied in estimating future traffic:

1. Traffic volume is largely proportional to population and to motor vehicle registration. This last relationship is shown in Fig. 1, taken from the *Report of a Survey of Transportation on the State Highways of Pennsylvania, 1928*. The vertical plotting is on a logarithmic scale and the curves for traffic and registration have been moved into contact in each case, for purposes of comparison.

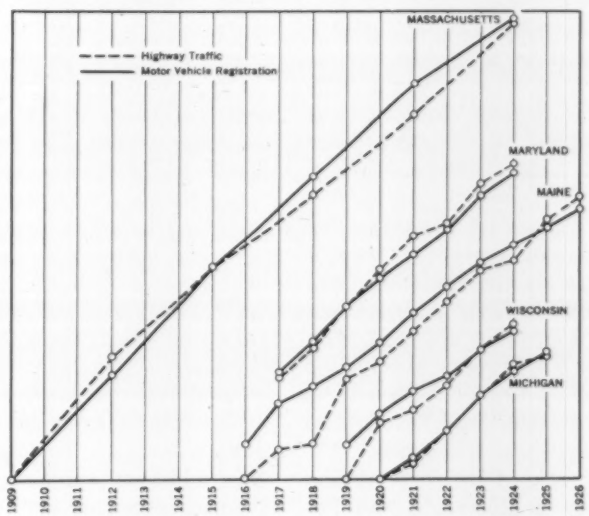


Fig. 1. Trends of Highway Traffic and Motor Vehicle Registration in Five States

From the Pennsylvania Highway Transport Survey, 1928

2. Traffic is essentially local.

3. Highway utilization (vehicle and tonnage miles) varies with highway classification and regional features, such as agricultural, industrial, urban, and suburban characteristics.

4. Truck hauling is limited to short distances. The length of a profitable trip is, however, increasing.

5. Foreign traffic is usually a small part of the total traffic but may in certain cases become a large percentage.

6. Highway utilization is increasing absolutely, that is, faster than registration.

FIG. 2. ROUTE L, FROM RIVERSIDE TO SAN DIEGO, CALIF., AND SURROUNDING TERRITORY

From a Report by T. H. Dennis, Maintenance Engineer of the California State Highway Department

A PRACTICAL EXAMPLE FROM CALIFORNIA

The method of applying these principles of highway transportation is well illustrated in a *Report on the Orderly Addition of New Roads to the California State Highway System, 1930*, by T. H. Dennis, Maintenance Engineer, California State Highway Department. For example, he analyzes Route L, from Riverside to San Diego, shown in Fig. 2.

Local traffic is expected to increase as the tributary farming area is more intensively cultivated. Through traffic will increase in proportion as the distance from Riverside to San Diego, and from Los Angeles via Pomona and Elsinore to San Diego, is shortened by relocation and improvement. For this route is a logical alternate to relieve heavy traffic on the Coast route, as well as the most direct line from the San Bernardino and Riverside areas to San Diego and the south.

Traffic will also be greatly increased by construction on a more direct location between Riverside and Escondido and also of a direct connection from Pomona. Assume that such improvements are made during the next four years. The problem is to estimate traffic in 1940. Motor vehicle registrations for the years 1927 and 1929 for Los Angeles, Riverside, Orange, and San Diego counties show an annual increase of 9.5 per cent, but this is probably excessive. Basing the population increase on the traffic census for 1910 and 1920 and projecting ahead to 1940 at the same rate, and assuming that there will be one vehicle registered for every two and a half people in 1940, the increase is found to be 6 per cent each year. This seems reasonable. For a 12-hour period the traffic may then be found as follows:

TRAFFIC	SUNDAY	WEEK-DAY
Present traffic (average)	1,450	820
Normal increase by 1940, at 6 per cent per year	870	480
Increase of through traffic on account of Pomona to Corona connections, 25 per cent of the through traffic on the Coast route	2,000	1,000
Total estimate for 1940	4,320	2,300

Such use of traffic data is not confined to California. Letters from state highway engineers in 41 states show that 31 of these states now use to a greater or less extent the results of traffic counts or of transportation surveys in planning highway improvements.

WHEN TO BUILD ROADS

The answer to the question "when to build roads" is based on the economic principle that whether a highway should be improved now or later depends on whether the annual saving in transportation costs will more than equal the annual cost of the improvement. The survey should show the extent to which the improvement of old, or the opening of new, traffic routes is economically justified. This is found by comparing the earning value of a state highway system (based on passenger miles and freight ton miles) with its present worth—replacement value minus depreciation. It should also estimate or show the cost of accidents preventable by highway improvement.

This question of "when" is closely connected with the previous one of "where." Under most conditions there is a greater demand for economically justified improvements than the available funds will cover. Then a highway transport survey will show which jobs should be done immediately and which can be deferred.

ECONOMICS INVOLVED

Suppose that over a certain route the traffic for the next ten years is estimated to average 2,000 vehicles per day. Consider the justifiable expenditure for shortening the route one mile.

It can be safely assumed that one-half the cost of operating a motor vehicle is road expense, say 5 cents per mile. Then the annual saving will amount to:

$$365 \text{ (days)} \times 2{,}000 \text{ (cars per day)} \times \$0.05 = \$36{,}500$$

This sum could then be applied to the annual cost of the new construction, which would consist of (1) annual interest on average value, considering depreciation; (2) annual maintenance cost; and (3) annual depreciation.

In addition, the time saved may be evaluated. The U.S. Government estimates the time value of a motor vehicle and its occupants as $3 per hour. Assume an average road speed of 30 miles per hour. The annual saving will then amount to:

2 (minutes to travel one mile) × 365 (days) × 2,000 (cars per day) × $0.05 (time value per minute) = $73,000.

STUDIES IN TENNESSEE

An example of a forecast of future traffic and an analysis of expected financial returns is given by N. W. Dougherty, M. Am. Soc. C.E., in the TRANSACTIONS of the Society, Vol. 94, page 497, in connection with the construction of highway bridges that are to be financed by toll charges in Tennessee. In brief, this method consists of a study of license numbers to find the percentage of vehicles originating in (1) the same county—local travel, (2) counties of large registration, (3) other counties of the state, and (4) other states.

A typical analysis is that shown in Table I, for the station at Spring Hill, Tenn., the relative location of which may be seen in Fig. 3. In 1926, the local travel at Spring Hill was 573 vehicles per 12-hour day, from which the ratio of travel to weighted registration is found to be 0.091. That is, approximately one-tenth the tributary motor vehicle registration passed the station every day. All local registration was considered tributary, but only part of the more distant registration was so considered.

TABLE I. ANALYSIS BY LICENSE NUMBERS OF VEHICLE TRAFFIC PER 12-HOUR DAY AT SPRING HILL, TENN., IN 1926

County	Percentage of Total Cars Registered That Contribute to Traffic	Cars Registered in County	Weighted Value
Williamson	80	2,908	2,326
Maury	60	3,164	1,898
Giles	30	2,655	797
Lawrence	30	2,315	695
Marshall	20	1,917	283
Hickman	10	1,115	112
Lewis	10	644	64
Total	..	....	6,175

In Table I the weighted value was obtained by assuming that the percentage of the cars tributary to

FIG. 3. SPRING HILL STATION, TENNESSEE
With the Relative Locations of the Counties Listed in Table I

the station varied with the distance from the source to the station; and by the engineer's judgment as to the influence of the topography and other characteristics of the localities. The curve of registration was then extrapolated from 1920 through 1927 to 1940, by assuming (1) the probable increase in population, (2) the number of persons per vehicle, and (3) contributary percentages, to remain the same.

HOW TO BUILD ROADS, AN IMPORTANT QUESTION

To throw light on the best type of road for a given location, a survey should provide the following data:

1. Present, and probable future, daily, seasonal, and yearly traffic flow and its distribution on the highway system.

2. Maximum loading and frequency of such loads as an index of the proper pavement width and design for highways contiguous to large centers of population.

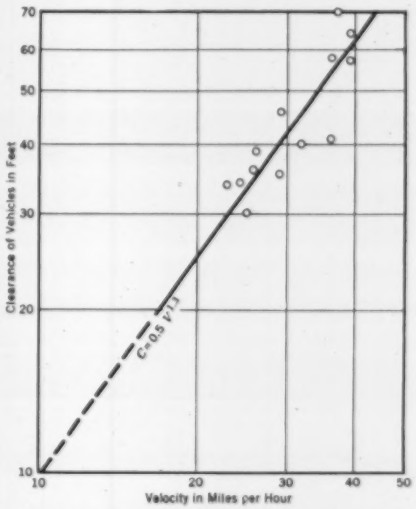


FIG. 4. LOGARITHMIC CHART RELATING CLEARANCE OF VEHICLES TO THEIR VELOCITY

3. Cost of vehicle operation over various types of roads. Aside from traffic, many physical problems affect the selection of pavement types but such problems will not be considered here. From the traffic point of view certain general principles are being established that may be used in selecting the proper type and width of paving. For example, a certain highway route is estimated to have an average daily traffic of 1,500 vehicles for the next ten years. Should it be paved with a heavy type of surface, such as concrete or brick, or with a medium type—a bituminous macadam or its equivalent? Assume that the annual costs for these two types of surfacing are as follows:

FOR HEAVY TRAFFIC TYPE:		
Interest	$2,000	
Depreciation	2,000	
Maintenance	350	
Total		$4,350
FOR MEDIUM TRAFFIC TYPE:		
Interest	$1,250	
Depreciation	1,000	
Maintenance	1,000	
Total		$3,250

Taking the average difference in vehicle operating cost as one-half cent a mile, the justifiable annual expenditure for the costlier pavement can then be computed as follows:

$$1{,}500 \times 365 \times \$0.005 = \$2{,}737.50$$

This is more than the annual difference in cost of the two types, and the higher type is justified provided that the assumed figures of cost are correct. It is thus seen to be the purpose of the traffic survey to supply accurate data on operating costs and to assist in forecasting future traffic conditions.

TRAFFIC SPEEDS AND ROAD CAPACITY RELATED

As to the question of the traffic capacities of different widths of paving, there is no very definite answer. For conditions in California, Mr. Dennis is using the follow-

ing ultimate safe capacities for computing width of pavement for the estimated traffic in 1940.

TYPE	NUMBER OF VEHICLES
Two-lane roadway	700 vehicles per hour
Three lane roadway	2,000 vehicles per hour
Four-lane roadway	3,200 vehicles per hour

For this volume, fast traffic traveling at 40 miles per hour must be permitted to pass the slower. A

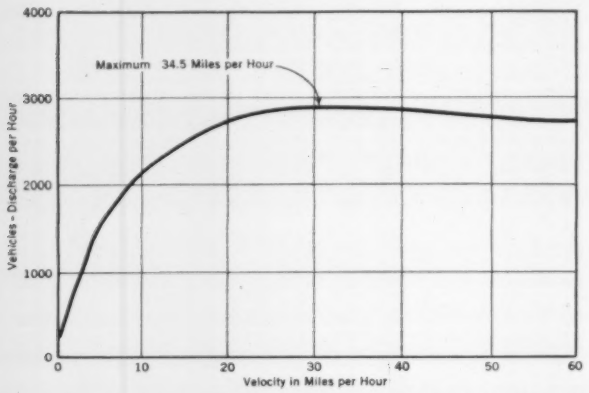


FIG. 5. RELATION OF DISCHARGE TO VELOCITY OF VEHICLES

safety factor of about 30 per cent is also included, that is, traffic on a two-lane roadway could be increased to 1,000 vehicles per hour without resulting in serious delays.

From the results of an aerial survey of highway traffic between Baltimore and Washington, D.C., A. N. Johnson, M. Am. Soc. C.E., derives a formula for the theoretical discharge of a two-lane highway, which he explained in an article in the *Proceedings of the Eighth Annual Meeting of the Highway Research Board*, 1928. The number of vehicles per hour, N, passing a given point at a velocity of V miles per hour, with an average car length of 15 ft., is as follows:

$$N = \frac{5{,}280\ V}{C + 15}$$

in which C, in feet, is the clearance between the cars. The observed clearance, Fig. 4, is seen to vary approximately as the 4/3 power of the velocity.

If we introduce this value of C in the formula, we have the discharge per hour for a single line as:

$$N = \frac{5{,}280\ V}{0.5\ V^{1.3} + 15}$$

Results are shown by the curve plotted in Fig. 5.

APPLICATION TO MULTIPLE LANES

In order to keep the motorist to his proper lane so as to permit unobstructed passing, Massachusetts has introduced the dual-type highway, in which the center lanes are paved with a rougher, less attractive paving. Traffic is automatically kept to the outside so that passing may be made on the inside lanes in safety. From the fact that the annual cost of traffic accidents in the nation as a whole is estimated at one billion dollars, the matter of safety is seen to be of utmost importance

Under conditions of free passing, the actual capacity of a four-lane road will exceed but little the theoretical capacity of a two-lane route. A highway should not only permit maximum traffic but it should permit it unobstructed. This means that free passing should be available at all times. This can be accomplished by permitting on the inner lane only cars traveling at such a speed that they are potentially passing the cars on the outer lane. This, in effect, is to provide unobstructed travel in one lane each way.

EFFICIENT EXPENDITURES VERSUS POLITICAL PRESSURE

Those responsible for the location, building, and maintenance of highways often find it necessary to justify their actions to politicians and the public in general. Specific, detailed information such as that supplied by a traffic survey is the best means available. Highway officials are not slow to emphasize the value of this phase of the traffic survey.

Political changes in highway departments constantly menace efficient administration. An extended program based on the results of a transportation study is the most efficient means of showing the value of a permanent staff. A long-time budget set up to meet a definite plan of operations over a considerable period is the best possible defense against the tendency to divert the gas tax from the control of the state highway department.

For example, the Department of Public Works of California has prepared a report setting forth a 10-year budget for the state legislature. This plan received the endorsement of the engineering staff and also that of the state administration, with the comment that the policy adopted must be based on traffic and not on political pressure.

WHAT SURVEYS WILL ACCOMPLISH

Traffic surveys must necessarily form the basis of all computations concerning traffic. A traffic survey, however, is no more than a record of conditions at the time the census is taken. In itself it gives no indication of the future. Of the 41 highway officials who expressed their opinions on the questions which have been discussed in this paper, several in widely separated states declared that a traffic survey was not necessary for predicting future traffic and that, owing to detours and other road conditions, it might give a very wrong picture. Sound engineering principles must still be the guide in road building.

By means of past records, certain underlying principles can be established; and a continued record will make these and other principles and the trend in traffic movements more apparent. State highway engineers are finding periodic traffic surveys of great value for determining the suitability of certain types of surfaces for a given amount of traffic—in brief, for solving the problem of what type of road is best or most economical to serve the expected traffic with the money available.

Specific, detailed data supplied by traffic surveys are the most effective means of justifying highway expenditures to legislative bodies or the general public. Backed by indisputable facts, highway departments may secure, execute, and plan long-time programs, thus securing the maximum return for highway expenditures.

An American Memorial Bridge in Belgium

Featuring an Artificial Granite Surface for Decorative Carvings

By Edward H. Tashjian

Civil Engineer, Formerly Representing Ohio Battle Monuments Commission

SURFACE coatings on concrete for adding to the esthetic appearance of the finished structure have received considerable attention in recent years, particularly for decorative bridge work. However, for surfacing the memorial bridge over the Scheldt, Mr. Tashjian developed a unique integral surface coating! This mix, which was poured slightly in advance of the main concrete, was tamped in between the forms and a layer of wire mesh placed about two inches back of the forms and supported by stiffening bars. The resulting surface was worked readily with hand carving tools, bush hammers, and tooth chisels.

NEAR the village of Eyne, is the beautiful American Memorial Bridge spanning the Scheldt River, a monument erected by the State of Ohio as a memorial to her heroic dead who fell in this neighborhood during the last days of the World War. The plains of Flanders, stretching from the winding Scheldt to the west, and the range of wooded hills not far from the opposite bank, were wrested from the enemy after a fierce and heroic struggle, in the course of which over three hundred men fell while forcing a passage across the river in the face of heavy shelling.

In 1929, the Battle Monuments Commission of Ohio generously replaced the bridge destroyed by the retreating Belgian troops and perpetuated the achievements of Ohio's 37th Division. By looking closely at one of the accompanying illustrations it is possible to see the bold carving along the arch, which reads: "In commemoration of the crossing of the Scheldt by the 37th American Division 1918."

The two narrow gaps, which attract the observer's attention as they seem to separate the central section of the span from the rest of the bridge, constitute part of a very clever engineering design by the Belgian State engineers, Heylbroeck and De Nayer. In fact, the central section is free and supported at both ends by seven sets of steel rollers and plates, which restrain lateral displacements but allow angular and longitudinal movements. The bridge is, therefore, of cantilever design relieved of secondary stresses and unaffected by possible settlement of its piers, which rest upon somewhat doubtful soil. A longitudinal section of the bridge is shown in Fig. 1.

The problem of combining stone particles to reproduce the fine white granite surface required by the architect's specifications, and—what is vastly more important—that of finding and developing a method of construction to limit the thickness of the outside layer, to secure a perfect bond, and to forestall all cracking, were of absorbing interest. They involved many experiments during the last months of 1928. As the work progressed, in the spring of 1929, the Belgian engineers already mentioned and others from the Ministry of Public Works in Brussels became enthusiastic about the adopted method. Since then, all who have seen this bridge or have been informed as to the method used, are convinced that the problem of surfacing concrete

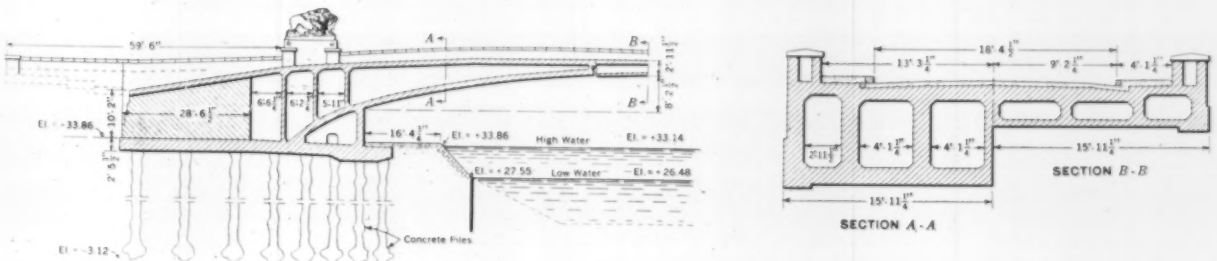


Fig. 1. Longitudinal and Cross Sections Through the Cantilevered Span

with a lasting decorative coating has been solved in a satisfactory manner.

It is hardly necessary to dwell on the fact that the various methods for applying surface coats now generally

HAND CARVED ORNAMENTS ON BRIDGE FACES
Bush-Hammered and Tooth-Chiseled Surfaces

in use give but temporary results, as the surfaces deteriorate rapidly. Others of the monolithic type, such as that obtained by suspending and lifting out metal sheets between the mass and the surface mix, work well on paper but at best give results inferior to those obtained at Eyne. This beautiful surface of crystalline nature—which is taken by all, except by experts, to be natural granite—has developed no crazing or checkerboard cracks and gives every assurance that it will never do so.

Some of the principal causes of deterioration inherent in the usual methods of placing such surfacing follows:

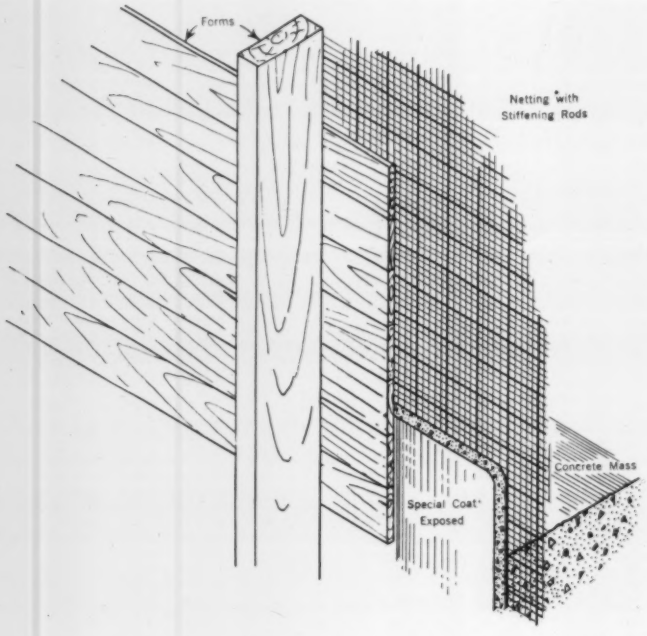
1. Coats applied on old or set surfaces will eventually fall off because, during their setting, chemical and physical changes take place internally which allow only a defective or partial adherence between the two.
2. An outside coat yields relatively to the mass behind because the mass is affected less by variations of atmospheric temperature and moisture.
3. A finish coat of cement and fine particles, produced by troweling the mass, is subject to excessive checking and rapid deterioration.
4. Without adequate reinforcement near the surface there is no provision against tensile stresses, which are greater than the concrete can withstand.

WIRE NETTING REINFORCES SURFACE

It will be noted that, in the process developed at Eyne, the surface coat is monolithic with the concrete of the mass, that there is no distinct cleavage between the two, that adequate reinforcement is provided close to the surface, and that the bush-hammered surface presents closely packed crystalline particles.

The ingenuity of the Indian in devising his snow shoes and a similar utilization of the remarkable function of wire netting as used by the English engineers to prevent the sinking of their narrow-gage tracks into the sands of the Arabian desert, became associated, by accident as it were, to lead to the method developed at Eyne.

A wire netting set a few centimeters inside the forms was found capable of maintaining a plastic mix of the material of the surface coat at a level sufficiently above that of the concrete of the mass to permit sufficient tamping to form a dense and homogeneous body. The coating keyed itself into the concrete by interpenetration



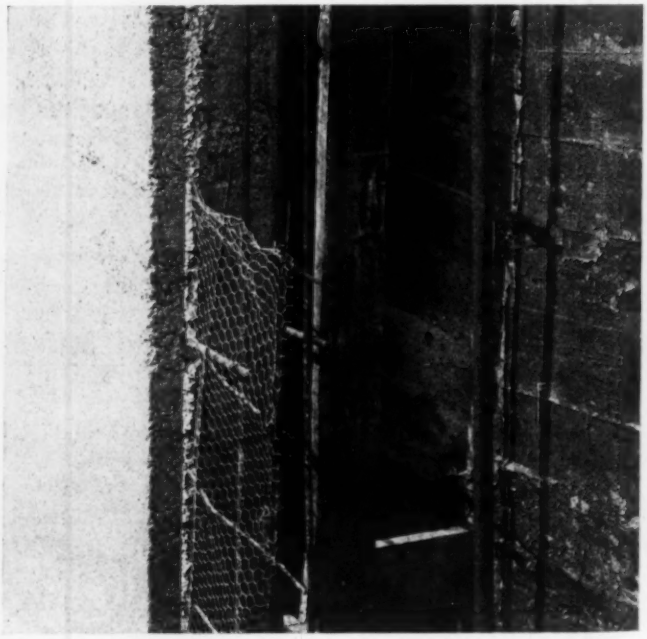


FIG. 2. DIAGRAM AND PHOTOGRAPH SHOWING METHOD OF REINFORCING AND PLACING THE COATING

through the meshes. After many experiments, a process was discovered which reduced the whole operation to a smooth routine giving uniformly good results.

The surface coat and the concrete of the mass of the structure were poured simultaneously, the former just a step higher and without interfering with the progress of the latter. The bond realized between the two was found to be perfect, as no separation in a distinct plane could be effected. Hammering, even on the day following placing, had no effect.

For mixing, transporting, placing, and tamping, four men did about 200 sq. ft. of surface a day. The bush-hammering, done by hand, was at the rate of 30 sq. ft. per man per day, but there is no reason why this cannot be done w.th mechanical equipment instead. The materials for the surface mix consisted of the following: 40 per cent quartz, 40 per cent white Carrara marble, and 20 per cent black Carrara marble, all ranging from fine to $^1/_4$ in. and mixed with a light-colored cement. Soot adhering to the surface is thoroughly washed away by showers. The thickness of the coat averaged about 2 in. Its cost—rather high—would not apply in the United States. However, many beautiful crystalline marbles found here would give excellent results when properly combined. The proportion of cement can be advantageously decreased by increasing the sizes of the particles. Too large a percentage of dust should not be incorporated in the mix.

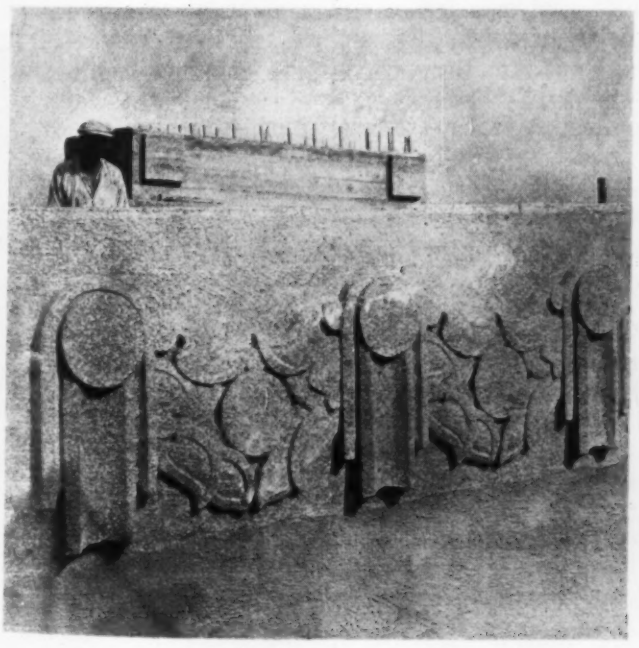
BISONS CAST IN CEMENT MOLDS

Sculpturing on the arches and piers was chiseled out by hand with frequent breakage of the tools because of the great toughness of the substance, even when only ten days old. The buffaloes, after a model by Moreau-Vauthier, Paris sculptor, were cast in cement molds. Very good results were obtained by this method, and the cost was comparatively much less than hand carving.

ROADWAY OF FINISHED BRIDGE
Showing the Ornamentation

The interesting results obtained at Eyne and the high opinion of eminent men regarding the merits of this method indicate that it will supplant faulty practices and contribute toward giving concrete the esthetic appearance it too often lacks.

The architects, Messrs. Walker and Weeks of Cleveland, are to be highly congratulated for their excellent design; the graceful arch and artistic carvings are admired by all who see this bridge.



CARVING DONE WITH HAND TOOLS
Concrete Facing Resembles Granite

ONE OF THE FOUR CAST CONCRETE BISONS
From a Model by Moreau-Vauthier

The Day of Opportunity

Planned and Coordinated Public Works to Meet the Present Economic Emergency

By MORRIS KNOWLES, M. AM. SOC. C.E.
PRESIDENT AND CHIEF ENGINEER OF MORRIS KNOWLES, INC., PITTSBURGH
and JAMES H. ALLEN, ASSOC. M. AM. SOC. C.E.
ASSISTANT ENGINEER OF MORRIS KNOWLES, INC., PITTSBURGH

NATION-WIDE conditions have forced long-continued idleness on so many that it has become the obligation of all citizens to bear a share of the burden. As Mr. Knowles points out in this article, the best good of all will be furthered by the purchase, by those who are able, of more than the mere necessities of life. Apparently, at the moment, the only general field in which supply does not exceed demand is that of public works improvements—municipal and public utility alike. Hence it is good business policy to purchase such improvements now, when labor and materials are at low cost levels. Such work not only results in public benefits but also serves to mitigate private need. If public projects are carried out on a sound basis of far-sighted planning, communities will be directly improved by their accomplishment and at the same time it is to be expected that private business will be stimulated.

IF PERSONAL and selfish attitudes are put aside, it will be found that, in addition to its depressing characteristics, today presents to practically all of us an opportunity for glorious service, the like of which seldom occurs in a lifetime. In ordinary times there are no widespread opportunities for such service. Everything moves along more or less smoothly. We are looking then for opportunities—to grasp and make the most of—for personal betterment. This is not wrong, in fact, it is desirable and rational. But such betterment, however great, is trivial and insignificant compared to the exhilaration of rendering real service to people in need. That not only is our opportunity today; it is also our duty and our responsibility. The several million people who are out of work and practically without funds will not be permitted to starve or suffer materially. Our country and our people are too big for that. Clearly, it is the duty of every one of us to do all he can to help those in want.

QUESTION OF PROVIDING WORK

Work is the thing that is wanted, and it is now up to us to provide it. The following experience is perhaps typical of many municipalities. One day early in the fall of 1930, when the problems of unemployment were first assuming a recognizable form, the mayor of an eastern city called in his city engineer and said to him, "I want to put 150 men to work Monday morning and I shall expect you to have jobs for them at that time."

Adding 150 men to the normal city crews at the end of the summer construction season represents a real problem. It was clearly a case for new construction, new projects, for which preliminary surveys had been made, plans drawn, and estimates completed. This particular city engineer met his mayor's request and put the men to work. Whether he employed them for better or worse depended not upon his ingenuity nor upon his ability to develop a project into the construction stage overnight, but solely upon how well the city had planned in earlier years for just this emergency. Nothing could more forcefully demonstrate the benefits of community planning than incidents such as these.

In providing jobs for the unemployed, cities without a plan spend much money extravagantly. Putting a large number of men to work on short notice—making work—is expensive, even wasteful, when there is no plan to assure that necessary and beneficial public projects will be carried out.

In cities where individual studies and reports of municipal needs have been coordinated into a comprehensive city plan, and where a financial program has been drawn up for carrying out that plan, the problem of "made work" to meet unemployment has been vastly simpler.

Let us then do sensibly our philanthropic work—the providing of jobs for those in need. Let us provide work which will result in sufficient returns to those engaged in it to buy at least the essentials of life, and more if possible. Also, let us carry out undertakings which are really useful and necessary; which will return benefits to those who make them possible, and give an impetus to renewed business activity.

The undertaking of public works is entirely feasible Public improvements carefully conceived, planned, and executed are the answer. They constitute the only sensible solution. Today more commodities than can be consumed under existing circumstances are available through private industry. It is absurd to think that individual enterprise should provide work by making more and more of such commodities.

PUBLIC WORKS TO STIMULATE PRIVATE BUSINESS

When private business fails it becomes the duty of society—of all the people—to share in, or lessen, the burdens of general adversity. Fortunately, in the field of public works there is no surplus of commodities. Instead there is a vast need and a demand for much improvement. Thus we can provide jobs and at the same time receive valuable returns from them. If we carry out this policy extensively and concertedly enough there are reasons to believe that sufficient stimulus may be given to accelerate the wheels of private business and to bring back general prosperity. Claims that there is not sufficient public work to meet the present emergency are not supported by facts.

During the past five years, the country's average annual expenditure for public works construction has been somewhat more than three billion dollars. This sum represents the carrying out of only those general improvements which were essential at the time. It does not by any means indicate that only ordinary, routine projects of a similar nature remain to be completed.

GREAT DEMAND FOR PUBLIC CONSTRUCTION

Today public construction needs, in addition to the ordinary requirements, exist in enormous volume. For example, of a national or regional nature are works to prevent disastrous floods. Again, during 1930 as well as in 1931, practically the entire country was in the grip of a severe drought. Works to ameliorate the serious effects of such an occurrence are urgently needed. In addition, there are other great waterways projects awaiting development, such as the Columbia River navigation and irrigation scheme, the St. Lawrence River navigation and power plan, and the Boulder Dam improvement and connecting aqueduct. More than two million miles of dirt roads in this country are waiting to be improved with modern surfaces.

All this represents only a small part of public construction needs. It is in cities and towns that perhaps more than 80 per cent of the needed public improvements are to be found. Briefly, they include street extensions; street paving and widening; water, sewer, and other utility provisions, municipally or company owned; parks, playgrounds, and school facilities; transportation, harbor, bridge, and viaduct problems; public building requirements; and needed developments in many other directions.

FINANCING AND BOND ISSUES

Obviously, from the point of view of work, the field of public construction could furnish needed projects sufficient to give jobs for a considerable period of time to more than the number in need.

To name the work is not nearly as difficult as to determine equitable means of planning and financing it. A campaign by welfare organizations in thousands of communities is being made to raise money to purchase relief for those in need. A large part of the sums so raised, together with other obtainable funds, may well be made available for municipal improvements. When improvements will result in benefits during future years, bond issues should be planned so as to spread the cost over a corresponding period. Where improvements are financed by bond issues, the increase in annual tax bills will be less burdensome at the present time than if all were paid for at once. In fact, when normal conditions return, the filling of certain needs at the present low rates for labor and materials might result in an actual saving in accumulated tax bills for these improvements. Loans much more liberal in amount than those now necessary were obtained from the people during the war. Our present emergency is just as real, even if it is not so spectacular.

In undertaking public improvement projects, the most important consideration is to carry out the work efficiently and economically. Excessive costs usually result, not from the extensiveness of programs, but rather from the lack of wise planning, sensible scheduling, and budgeting. The probability of unusual extravagance in hastily carrying out projects to meet the present emergency is great. But never has it been more necessary to keep waste at a minimum. For waste not only reduces the amount of possible work and the number of possible jobs, but also increases the unit costs and thereby diminishes benefits.

On the other hand, the volume of work which can be carried out, the number of jobs made available, and the equitable return to all, will expand in proportion as the undertaking is efficiently handled. At Kenosha, Wis., and St. Paul, Minn., an unusual volume of public works improvements is said to have been carried on during the past two years without any increase in tax rates. Careful planning of programs has made this possible.

PLANNING ASSURES MAXIMUM RETURNS

Obviously, the communities which will do the most in providing needed work, accomplishing worthy improvements, giving impetus to business activities, and bringing returns to the greatest number, are those which will develop needed improvements in accordance with carefully conceived physical plans and financial programs.

Such plans will determine the improvements needed, their order of importance, the method of accomplishment, and the results to be obtained. The coordinated program will determine means of financing, legal and practical limitations of various methods therefor, proper correlation of the total available revenues from all sources, with estimates of expenditures in total and by projects. Coordinately, recommendations for a definite, appropriate program of improvements—by departments, by projects, and by means of financing—may be practically made.

EXPERIENCED GUIDANCE REQUIRED

No community can afford not to be guided by a workable plan. The real cost is in not planning—for the results will be haphazard and extravagant. The urgent character of the present emergency cannot excuse failure to spend in accordance with a definite program on the ground that there is insufficient time for the preparation of plans. Rather it dictates more careful selection of guidance. In such cases, only those having extensive planning experience should supervise the development of plans. Such experience is the solid foundation upon which sound, wise, and effective planning and programming may be formulated a few paces ahead of required construction.

It is not intended to imply that the construction of public works is the cure for our present economic problems. Rather, attention is called to the use of needed public construction activities, carefully planned and executed, as a stimulant for our economic illness. A diagnosis of our condition shows that our usually robust organism of work—that is, through private industry—is in a weakened state. To build up resistance, to assist in the stages of convalescence and return to normalcy, there is prescribed the tonic of public construction, based on a long-range program of planning and budgeting. It is felt that this procedure will prove effective and economical.

Governmental Reorganization for Economy

An Engineer's Plan for the State of Washington

By C. E. PUTNAM

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CITY ENGINEER, TACOMA, WASH.

HOW to meet the public demand for lowered taxes without at the same time curtailing the service rendered by governmental agencies is a problem that those in public places are trying to solve. An eminent engineer's plan to save the taxpayers of the State of Washington as much as $25,000,000 a year by grouping the 39 county governments into seven districts, and by reorganizing the state government to eliminate a considerable duplication in overhead, is worthy of consideration. This article has been abstracted from a paper read by Mr. Putnam before the Tacoma Section of the Society, on November 9, 1931. His proposal has stirred up much interest among engineers in the Northwest and doubtless will appeal to members elsewhere. It will be interesting to see whether an engineer's plan based on economy and efficiency, if adopted, can continue in spite of political patronage.

IN recent years the protests of the taxpayers against the high cost of government have become increasingly insistent. Tax-levying bodies have been besieged with demands—from real estate and financial organizations, civic clubs, other organizations, and individuals—that the cost of government be lowered. Under the existing system this cannot be done without reducing service and lowering the maintenance of public institutions to a point below safety standards.

It is true that the rising cost of government, as reflected in the high tax rate, has reached a point where the amount of property now in the possession of counties for non-payment of taxes is alarming. Certainly this situation demands attention. The time for mere discussion of the taxation problem is past and the time for radical corrective action is here.

At present an insistent demand is being made for taxation relief through curtailment of governmental activities. However, a dilemma presents itself: while there is a demand for lower taxes on the one hand, there is a protest against loss of service on the other. For example, contrast the demand for curtailment of state printing activities with that for distribution of agricultural reports and information. Other examples may be cited, such as demands for reduction in city and county expenditures as against increasing pressure for more and better maintenance of roads and streets.

The present organization of the government of the State of Washington, as shown in Fig. 1, is made up of 156 elective officers. The Governor appoints 14 heads, who have the management of 29 departments, in which there is much duplication of effort. Records have been found duplicated in as many as three departments.

The present organization of the county governments, shown in Fig. 2, is made up of about 20 elective officials in the larger counties. Some of the sparsely settled counties are unable to afford a County Engineer. The pay of officials in most of the counties is about equal to a laborer's wages, and is reflected in the service returned.

For the past few years I have made a study of these conditions and have worked out a plan which I believe is practicable and will afford the taxpayers relief from the rising cost of government by consolidation of certain state and county offices. This consolidation is designed to eliminate the waste and expense of excessive supervision.

CONSOLIDATION OF COUNTY GOVERNMENTS

This plan proposes the consolidation of the present 39 counties of the state into 7 districts. A new House

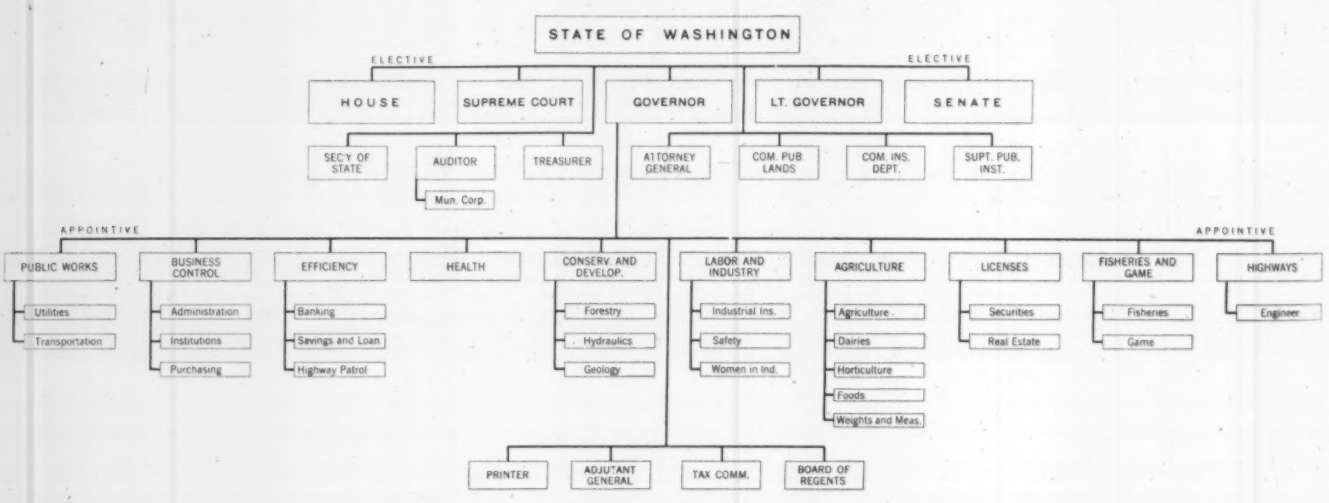


FIG. 1. PRESENT ORGANIZATION OF THE GOVERNMENT OF THE STATE OF WASHINGTON
98 Representatives and 48 Senators

of Representatives will be substituted, in which the new District Commissioners, 3 from each district, will serve as Representatives, and the size of the present Senate will be reduced to 7 Senators, one to be elected from each district. It also proposes, among other things, abolition of the present Code Department and the reallocation of all present departmental functions through the combination of the various offices and activities in order to centralize responsibility and obtain better management and efficiency. In order to effect such a change, the plan presupposes that such amendments as may be necessary will be made to the state constitution.

In outlining this program, a better picture of the proposed new governmental structure may be obtained by consideration in detail of its main component parts, as follows:

1. Redistricting the state
2. Reconstitution of the state legislature
3. Revision of state offices

The boundaries of the 7 districts, as shown on the accompanying map of the state, Fig. 3, will follow present county lines and the new district seats are to be chosen by the people. As shown in Fig. 4, each district will elect:

1. One Senator for a term of six years, the term to expire at the same time as that of other state elective officials.
2. Three District Commissioners at large, whose terms shall also be for six years, except for the first election. (At the first meeting of the Commissioners of a district after the first election, the Commissioners shall draw by lot for terms of 2, 4, or 6 years.)
3. One Clerk-Auditor, for a term of six years.
4. One Assessor-Treasurer, for a term of six years.

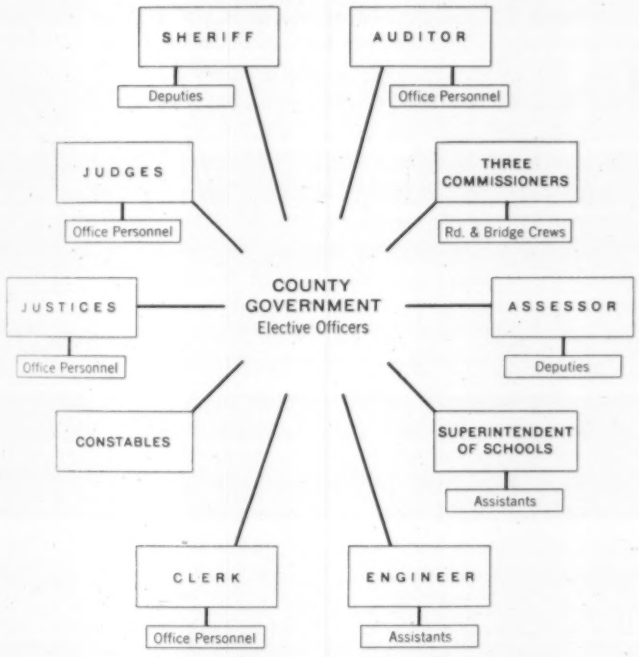


FIG. 2. PRESENT COUNTY ORGANIZATION
In Each of the 39 Counties of the State

Superior Court Judges are to be appointed for life by unanimous choice of the Commissioners of the district, but subject to removal for cause by the Supreme Court of the state.

Present County Superintendents of Schools, of which there are 39, are to be replaced by 7 District Deputy Superintendents of Schools appointed by, and responsible to, the State Superintendent of Schools. Present District School Directors are to function as they now do.

FIG. 3. PROPOSED GROUPING OF COUNTIES TO CREATE SEVEN DISTRICTS
District Boundaries Follow Present County Lines

Present Sheriffs (39) are to be abolished and their duties taken over by the State Police. One Constable is to be appointed in each district by Superior Court Judges, to serve as court officer only. Present Coroners (39) are to be replaced by District Coroners (7) who are to be appointed by the District Commissioners.

The present office of Justice of the Peace will be abolished and the judiciary duties and functions will be discharged by District Circuit Judges, appointed for this particular work by the District Superior Court Judges from among their own members, who shall serve for specified periods.

Removal from office of district elective officers may be effected by impeachment or by order of the State Supreme Court. District appointive officers, such as deputies and others that may be designated, may be removed by action of the District Commissioners when their superior officer fails or refuses to act.

STATUS OF ENGINEERS ENHANCED

The present County Engineers, of whom there are 30, are to be replaced by 7 District Engineers, appointed by, and responsible to, the District Commissioners. It will be noted that the seven proposed District Engineer organizations are to be substituted for the present County Engineer offices.

Prospects for advancement for an engineer in county service at present are not very alluring, as the average pay of County Engineers in 36 of the counties is about $150 per month. It is certain that to replace the present County Engineer system with the proposed District Engineer organizations, which of necessity would be similar to the State Highway organization, would offer the engineer greater opportunity for practice and advancement in his profession.

Under the new plan, the present House of State Representatives (98) and the State Senate (42) are to be replaced by a new legislature composed of the 21 District Commissioners sitting as a House of Representatives, and a Senate composed of one Senator elected from each district. Both of these bodies are to meet once a year, on call of the Governor or on unanimous demand of other state elective officers, with the exception of the Lieutenant Governor.

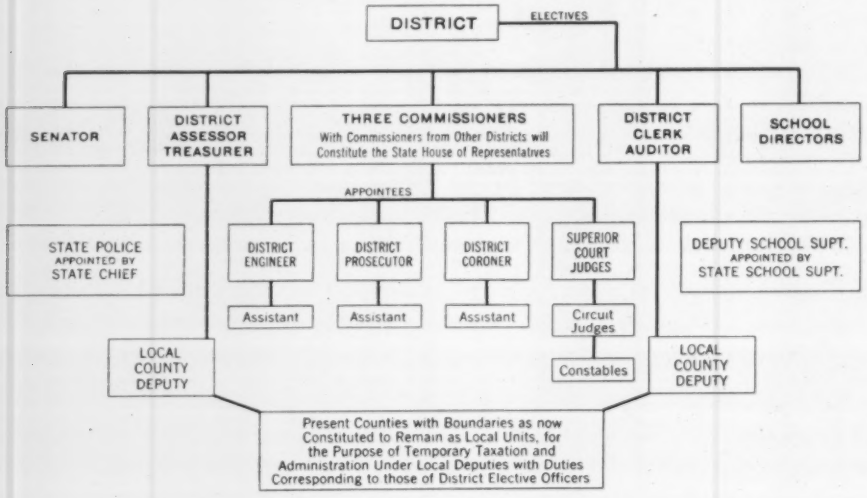

DISTRICT
ELECTIVES
SENATOR
DISTRICT ASSESSOR TREASURER
THREE COMMISSIONERS
With Commissioners from Other Districts will Constitute the State House of Representatives
DISTRICT CLERK AUDITOR
SCHOOL DIRECTORS
APPOINTEES
STATE POLICE APPOINTED BY STATE CHIEF
DISTRICT ENGINEER
DISTRICT PROSECUTOR
DISTRICT CORONER
SUPERIOR COURT JUDGES
DEPUTY SCHOOL SUPT. APPOINTED BY STATE SCHOOL SUPT.
Assistant
Assistant
Assistant
Circuit Judges
Constables
LOCAL COUNTY DEPUTY
LOCAL COUNTY DEPUTY
Present Counties with Boundaries as now Constituted to Remain as Local Units, for the Purpose of Temporary Taxation and Administration Under Local Deputies with Duties Corresponding to those of District Elective Officers

FIG. 4. PROPOSED ORGANIZATION FOR EACH OF THE 7 DISTRICTS

Vacancies in the office of Senator are to be filled for the remainder of the unexpired term by temporary appointment made by unanimous choice of the District Commissioners of the district in which the vacancy exists.

The Lieutenant Governor shall be relieved from duty as presiding officer of the Senate, and both the Senate and the House of Representatives shall elect their own Chairman or Speaker. The Senate and House, jointly sitting as a court, shall have the power to impeach any state elective officer and shall meet and try any case referred to them by the State Supreme Court when called by the Governor to do so. Both the Senate and the House shall have the power of instituting such investigating committees as they may deem advisable. The committees so appointed are to serve without pay.

REVISION OF STATE OFFICES

The organization, after consolidation of duties and functions in accordance with the proposed plan, is shown in Fig. 5. From this organization chart it may be noted that the Governor is to have as his Advisory Board the following state elective officials: a Lieutenant Governor, a State Secretary-Treasurer, a State Auditor, an Attorney-General, and a State Superintendent of Schools.

The Advisory Board will appoint all executive state boards and commissions, each of which shall have as chairman an appropriate member of the board, whose office is more immediately concerned with the work. The personnel of such boards and commissions shall be restricted to state elective and appointive officials who shall serve without additional pay.

Any investigating committees or commissions requested by the Governor shall be appointed only with the consent of the Advisory Board, and the services so rendered shall be paid for from funds budgeted for that purpose only.

The Advisory Board shall have the power to remove appointive state officers as designated for cause, and shall try, sitting as a court, any cases referred to it by the State Supreme Court for appropriate action.

In case of vacancy, the Governor shall appoint the Justices of the Supreme Court to serve for life, with the consent of the Senate. He shall also appoint a State Engineer, a State Chief of Police, and a State Adjutant-General. The Governor shall remain the Commander-in-Chief of the National Guard.

The Lieutenant Governor is to be a full-time official, residing at the capital, to whom shall be assigned the administration of certain offices, the same as other elective officials. The Lieutenant Governor shall appoint the State Director of Health and shall have supervision of the State Printing Office, the State Central Mailing Bureau, and the State Transportation Pool.

STATE POLICE DEPARTMENT PROVIDED FOR

A State Police is contemplated, similar in organization to the successful systems in use for many years in the East, in such states as Pennsylvania and New York. The present Highway Patrol is to be a separate branch but also available for police work in emergency, or as directed by the State Chief of Police, who shall also administer the Bureau of Weights and Measures. The State Police shall be furnished with transportation for normal requirements but shall have preferred call on the State Transportation Pool in an emergency, of which emergency the State Chief of Police shall be the sole judge.

Because of the abolition of the office of County Sheriff, the State Police Department shall take over the policing of the state, but incorporated towns and cities shall maintain such police force as they deem fitting and proper. Incorporated cities and towns shall also be delegated the right to elect such magistrates as they may require to discharge the functions now handled by the municipal police courts.

It is contemplated that the State Superintendent of Schools will have supervision of both public schools and institutions of higher learning. Deputy Superintendents of Schools are to be appointed for each district, to coordinate and direct the public schools in a manner similar to that in which present County Superintendents function. The State Superintendent shall appoint Boards of Regents for the various state institutions of higher learning, to serve without salary.

It will be noted that various agricultural, scientific, and other development, conservation, and propagation departments are listed in Fig. 5, under the head of Superintendent of Schools. It is contemplated, however,

that these functions may well be consolidated with departments and services now fully organized and functioning in the various colleges, departments, and schools with considerably less duplication than now prevails.

ADEQUATE SALARIES FOR OFFICIALS

No attempt will be made to specify the emoluments of office. However, it is believed that, for success, a plan of this type, similar to the city-manager form of municipal government, requires a high type of direction. The compensation therefore should be sufficient to attract a high type of management, and in keeping with the responsibility. True economy is shown by results, and even with a much higher salary scale the over-all cost may well be less than at present obtains.

Only one suggestion is made in regard to part-time officials—that the compensation of Senators be on a per diem basis, in the neighborhood of $20 per day, with travel expenses on a fixed mileage basis similar to the system used in the U.S. Army, for example.

SUBSTANTIAL FINANCIAL SAVINGS POSSIBLE

A complete financial analysis of the possibilities of the proposed plan is now being made by a committee composed of leading attorneys and engineers of the state. As a preliminary estimate, a saving of approximately $5,000,000 in salaries of state officials and in operating expenses will be possible through adherence to the plan for a period of two years. The large savings to result from the centralization of present county activities in the larger districts will bring the total saved up to about $25,000,000 yearly.

With a personnel comparable to that of industrial corporations, imbued with a patriotic desire for efficiency and economy in management, savings of the order indicated are not only entirely practicable but a certainty. If, when corporations are amalgamated into larger holding companies, the estimated financial savings are realized, is there any reason why such should not be the case with centralized responsibility in governmental activities?

The organization shown in the foregoing outline is tentative. As far as allotment of present Code Departments is concerned, reorganization would no doubt be accomplished by legislative enactment. Careful consideration of duties and functions at that time might show the advisability of a slightly different arrangement from that here outlined. However, this plan, in its fuller aspects, is logical and practicable, and represents a forward step in the renaissance of the present governmental structure. In view of the urgent demand for tax relief and the demonstrated possibilities for economy inherent in this program, patriotic motives and the future well being of our people most certainly demand that this plan or some modification of it be given a fair trial.

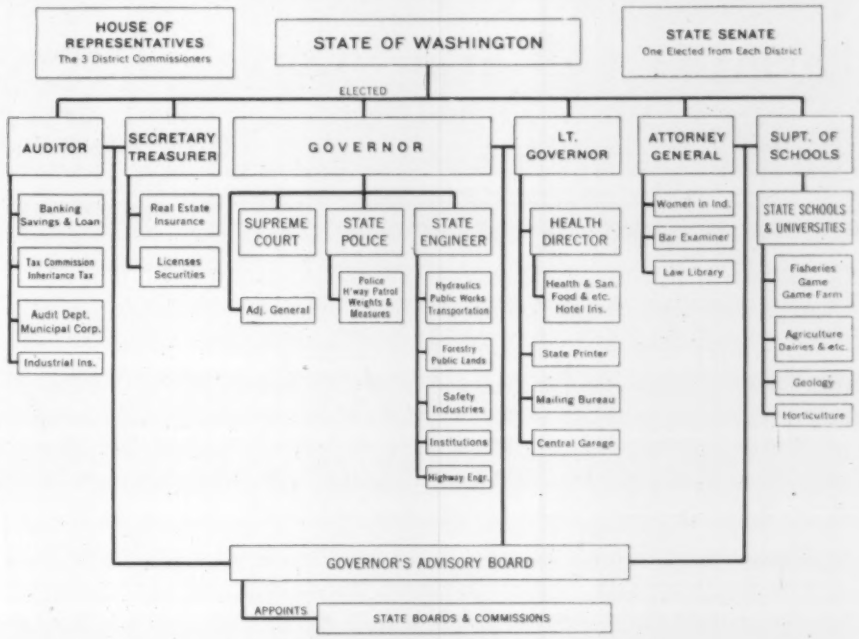
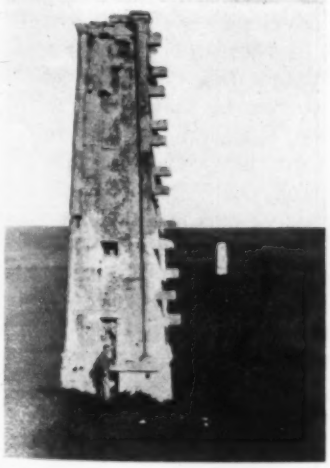


FIG. 5. PROPOSED STATE ORGANIZATION
21 Representatives and 7 Senators



ANCIENT HYDRAULIC DEVICES, CALLED SUTERAZISI

The masonry obelisk shown at the left is a device once used by Turkish engineers at intervals on their inverted siphons of lead or clay pipe. Each structure rises to the hydraulic grade line and originally conducted the water to a stone or lead basin in the top of the structure. An outlet pipe carried the water back to the valley floor level, where it continued on its course. Of several suggestions made as to the purpose of a *suterazisiler* the most probable appears to be for the location of leaks in the inverted siphon. The use of *suterazisi* has been abandoned long since, and the original clay or lead siphon pipe has been replaced with cast iron. At the right is a similar structure on the Aqueduct of Valens, built by the Emperor Valens (364 to 378) as a part of the ancient water supply system of Constantinople. Photographs and data have been furnished by Waldo E. Smith, Jun. Am. Soc. C.E.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Laying Out a Circular Curve with Tapes

By W. E. Howland

Professor of Civil Engineering
Purdue University, Lafayette, Ind.

THE curve generated by a point which moves so that its distance, z, from one fixed point is equal always to a constant, K, times the distance, w, from another fixed point is a circle. The fixed points are called generating points. This simple idea can easily be proved by setting up an equation of the curve in the Cartesian coordinate system and observing that the resulting equation is of the known form of a circle. The radius of the curve is $\frac{K}{K^2-1}$ times the distance between the generating points. The distance from the center to the outside generating point is K times the radius.

I found a proof of this theory in a very interesting old book, *A Treatise of the Method of Fluxious and Infinite Series*, by Sir Isaac Newton, published in 1737. Newton presents the proof as an example of his new concept of what we now call differential calculus. More exactly, Newton's proof covers a general method for drawing tangents to curves when the curves are defined by distances from fixed points.

It would seem that these principles would sometimes facilitate the laying out of a curve in the field, in particular when instruments and tables are not available, when the center of the circle is not accessible, when the curve is not long, and when time is an important factor.

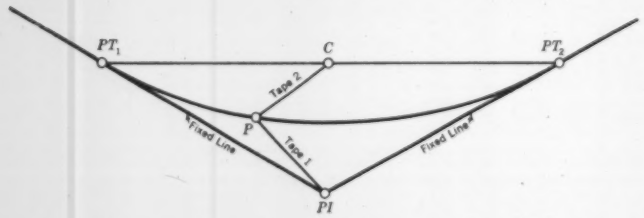


Fig. 1. Curve Located Without a Transit

In practice, as indicated in Fig. 1, locate the point of intersection, PI, of the two lines to be connected by a circle, and the points of tangency PT_1 and PT_2. Find the midpoint, C, of the chord. Drive stakes with nails protruding at PI and at C. Find the ratio, K, of the length of the tangent to the half chord length. With two tapes in hand, their ends looped over the nails on the stakes, move out toward any other point to be located. The point will be on the curve when its measured distance from PI is K times its measured distance from C. Thus, one man could quickly locate a large number of points on the curve.

If the curve is too long to be reached from a fixed point by a single length of tape, then divide the curve into two parts, determine a new pair of generating points for each part, and locate the two parts of the curve from these points.

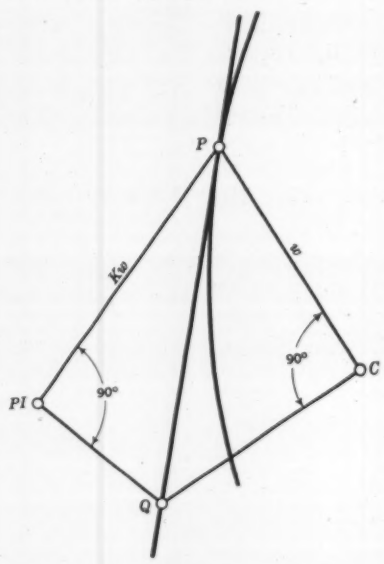


Fig. 2. Locating a Tangent

Newton's analysis also provides an interesting and useful method for locating the tangent to the curve at any point, as illustrated in Fig. 2. Let the length of line joining any point on the curve P, with C, the generating point, be w. Then the distance of P from PI is Kw. Erect from PI a perpendicular to the line Kw, and from C a line perpendicular to w. The point of intersection, Q, of these two lines is on the tangent to the curve at P.

Spillway Discharge Calculations

By Lewis R. East

Associate Member American Society of Civil Engineers
Engineer, State Rivers and Water Supply Commission,
Blackburn, Victoria, Australia

IN carrying out a series of investigations dealing with spillway design, I have used with success a simple graphical method developed by W. A. Robertson, of the Victoria State Rivers and Water Supply Commission, who was associated with me in this work. This method, which is analogous to that explained by R. D. Goodrich, M. Am. Soc. C.E., on page 417 of the February issue of Civil Engineering, was based on one outlined by Robert E. Horton, M. Am. Soc. C.E., in an article on the regulating effect of a storage reservoir. This appeared in *Engineering News-Record*, Vol. 81, page 455.

In the simplest case, an example of which will be given, the reservoir is assumed to be full to the spillway crest level at the commencement of the flood, and discharge from the reservoir is assumed to take place only over the spillway. The method, however, can readily be adopted for use under any conditions of stor-

age and discharge. It is also assumed that the rate of flood inflow is known at sufficiently close time intervals to permit the preparation of a reasonably correct flood hydrograph, from which the inflow in acre-feet during equally close intervals throughout the flood can be obtained.

NOTATIONS AND THEORY

Let t = length of the time interval in hours
I = inflow in acre-feet during any particular time interval
S_1, S_2 = storage above crest level in acre-feet at the beginning and end of this interval
Q_1, Q_2 = rates of discharge from reservoir in second-feet at the beginning and end of the same interval
D = discharge from reservoir in acre-feet during this interval. (1 sec-ft. for 12 hours is taken as 1 acre-ft.)

Therefore $D = \frac{Q_1 + Q_2}{2} \times \frac{t}{12}$

Since the change in storage equals the inflow less the outflow, the general equation of volume relations during any time interval may be expressed as follows:

$$S_2 - S_1 = I - D$$

$$S_2 - S_1 = I - \frac{Q_1 + Q_2}{2} \times \frac{t}{12}$$

whence $S_2 + \frac{Q_2 t}{24} = I + S_1 - \frac{Q_1 t}{24}$

Let $S_1 - \frac{Q_1 t}{24}$ and $S_2 + \frac{Q_2 t}{24}$ be represented by F_1 and F_2, respectively. Then

$$F_2 = I + F_1 \quad [1]$$

It will be seen that the values of F_1 and F_2 are functions of the height of the flood waters above the spillway crest. Therefore, if the values of F_2 can be found at various times during the passage of a flood, the corresponding heights of flood waters above the spillway crest at these times can be readily determined.

The method involves the determination graphically of successive values of $I + F$, for the various time intervals during the flood. To obtain the value of F_2 at the end of any period, the value of F_1 at the commencement of that period is added to I, the inflow during the period. From this value of F_2, the height above spillway crest at the end of the period can be obtained; or the process can be continued successively until the maximum value of $I + F_1$ is reached, which will be the greatest height reached by the flood waters in the reservoir during that particular flood.

In Table I are shown the known data as to spillway discharge and storage capacity at various levels, from which values of F_1 and F_2 are computed for these levels, using the selected time interval, t. The length of a suitable time interval will depend on the nature of the flood water under investigation. If it is of a "flashy" nature, a short time interval must be adopted. For the example which follows, a time interval of four hours was chosen.

TABLE I. DETERMINATION OF VALUES FOR F_1 AND F_2

Head on Spillway	Spillway Discharge, (Q)	$\frac{Qt}{24} = \frac{Q}{6}$	Storage Above Crest (S)	$F_1 = S - \frac{Qt}{24}$	$F_2 = S + \frac{Qt}{24}$
Ft.	Sec-Ft.	Acre-Ft.	Acre-Ft.	Acre-Ft.	Acre-Ft.
0.0	0	0	0	0	0
1.0	2,620	437	6,680	6,243	7,117
2.0	7,420	1,237	13,750	12,513	14,987
3.0	13,600	2,267	21,190	18,923	23,457
4.0	21,000	3,500	28,890	25,390	32,390

In Fig. 1, values of F_1 and F_2 are plotted to a suitable scale as abscissae against heights above the spillway crest as ordinates, to give the F_1 and F_2 height curves. It is assumed that values of I for the selected time intervals have been obtained from a flood hydrograph or by other means. These values of I are also plotted on Fig. 1 as abscissae against time ordinates, as shown. We thus have three curves in Fig. 1; I, the time curve; F_1, a height curve; and F_2, a height curve. From these, the F_2 time curve is obtained in the following way.

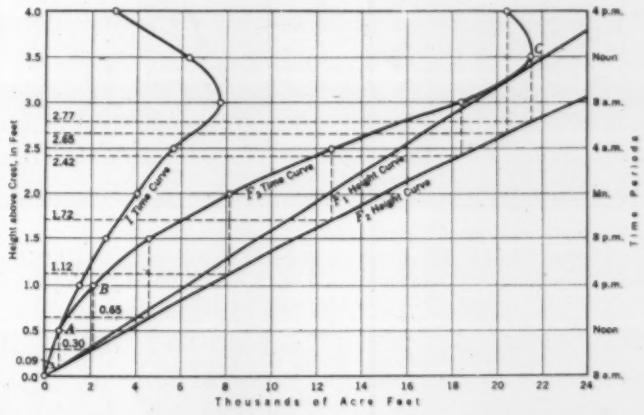


FIG. 1. DIAGRAM FOR RESERVOIR SPILLWAY CALCULATIONS

Starting at the first time interval, 8 a.m. to noon, F_1 is zero; therefore $I + F_1$, and hence F_2, are merely 1. The point A is thus the first point on the F_2 time curve. To find the head on the spillway at the end of this period, a perpendicular is dropped from A to the F_2 height curve, and the head read off directly, as indicated by the dotted line.

This head is found to be 0.09 ft., which is also the head at the commencement of the second period. The value of F_1 at this head is then marked off on a long strip of paper from the F_1 height curve and added directly to the value of I for the second period, noon to 4 p.m., thus obtaining the second point, B, of the F_2 time curve.

Again dropping to the F_2 height curve, the head at the end of this second period can be read, the next value of F_1 obtained, and the process continued as indicated up to or past the maximum value of I and F_1. This maximum value, marked C in Fig. 1, is found to occur at noon on the second day, at which time the massed floodwaters have reached a height of 2.77 ft. above the spillway crest. After this the water level in the reservoir commences to fall.

In order to tabulate the results of the investigation, and at the same time to check the accuracy of the work, Table II is prepared. Columns 4 and 6 are obtained from curves of storage above the crest and of the spillway discharge, which are plotted from the values in Table I. These curves may be included in Fig. 1, but to prevent

confusion they have been drawn separately and are not shown here.

TABLE II. TABULATION OF SPILLWAY HEIGHTS FOR A GIVEN FLOOD

Period Ends	Inflow During Period (I) Acre-Ft.	Head at End of Period Ft.	Storage Above Crest at End of Period (S_t) Acre-Ft.	Discharge at End of Period (Q_t) Sec-Ft.	Discharge During Period (D) Acre-Ft.
8 a.m.	...	...	...	...	..
Noon	580	0.09	560	140	23
4 p.m.	1,500	0.30	1,900	510	108
8 p.m.	2,660	0.65	4,200	1,400	318
Midnight	4,030	1.12	7,520	3,120	753
4 a.m.	5,640	1.72	11,750	5,900	1,503
8 a.m.	7,720	2.42	16,950	9,830	2,621
Noon	6,310	2.77	19,700	12,040	3,645
4 p.m.	3,020	2.65	18,700	11,250	3,882
	ΣI = 31,460			ΣD = 12,853	

AN ACCURATE METHOD

At any time within the period covered by the investigation, the total inflow should equal the total discharge plus the storage above the crest, that is $I = D + S$. This check has been made below to include the full period of the investigation.

Storage above crest	=	18,700 acre-ft.
Total outflow = ΣD	=	12,853 acre-ft.
		31,553 acre-ft.
Total inflow = ΣI	=	31,460 acre-ft.
Difference	=	93 acre-ft.
Therefore, error	=	0.3 per cent

It will be noted that the error is less than 1 per cent. In the somewhat elaborate investigations carried out by Mr. Robertson and me, this degree of accuracy was maintained without difficulty.

It is hoped that this description of a method that has stood the test of use in actual practice for several years will be of interest to members.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Practical Features in Constructing the St. Johns Bridge

TO THE EDITOR: Only a few of the practical features involved in the fabrication and erection of the St. Johns Bridge remain to be discussed after Dr. Steinman's description of the structure in the September issue of CIVIL ENGINEERING.

Since the type and size of the bridge are new in the annals of Pacific Coast construction, they presented new problems to the local steel fabricators. However, after making a careful preliminary layout of the method to be employed, the Wallace Bridge and Structural Steel Company, of Seattle, submitted a proposal for the construction of the work and were awarded the contract.

Among the unusual features connected with the fabrication and erection of the steel towers was the fact that the splice material and 1-in. rivets were proportioned for only 50 per cent of the developed compression stress of the vertical member. This in turn required an absolute metal-to-metal contact directly across the whole member on the horizontal sections. Throughout the course of the work, a milling tolerance of $^{6}/_{1,000}$ was the aim, and 80 per cent of the bearing sections were required to undergo this test. To accomplish this seemingly impossible machine shop precision over so wide an area of riveted members necessitated unusual precautions to prevent distortion of the cross sections during riveting.

After the section left the rotary mill, it was turned over to a crew of men whose function it was to file the planed faces down to a completely smooth condition. A face plate was employed during these filing operations, so that the proper percentage of bearing requirements could be fulfilled before the piece was assembled into the main part of the structure. The 84-in. rotary mill procured for the job was just able to cover the largest sections of the base. The dimensions of the largest piece to be milled were 7 ft. by 4 ft. 6 in., and the dimensions of the largest milled surface when assembled were 21 ft. 6 in. by 8 ft. 1 in.

Each tower was completely assembled in the assembly yard, and after the proper alignment had been made the connecting holes were reamed to full size. The inspection of the joints in the yard was made to cover the specification requirements, and it was decided that the weight of the steel, after being erected in a vertical position, was sufficient to close all joints tightly. This method of fabrication was fully vindicated later by the ease of erection in the field.

As far as I know, battered wood towers were used for the first time in the erection of the main steel towers. These towers were 344 ft. in height and 100 ft. square at the base, battering on three sides to 40 ft. by 45 ft. at the top. Since these towers carried a derrick weighing 65 tons, and the heaviest lift was 35 tons, they were supporting 100 tons at a height of 344 ft. The advantages of this method were that the steel could be erected quickly and set naturally without any distortion from the strain caused by the usual lifting equipment used in this type of construction. The cost of erecting and dismantling these towers was no more than that of the usual type of equipment.

Placing the cable bents required much care. On the 160-ft. concrete piers with a 10-ft. platform, it was found necessary to erect an A-frame derrick to lift the 17-ton towers into place on the pivoted shoes, securing them in their upright position by turnbuckles attached to wing plates, and to insert the horizontal bracing members. It was necessary to run guys to an unusual distance because of the marshy land surrounding the piers.

In accordance with the usual custom, the stiffening truss was assembled and reamed in the yard. Upon arrival in Portland, the erector riveted all members into two-panel lengths, lifting them into place from barges swung into position on the Willamette River. Instead of the usual traveling carriers employed for erecting this type of work, special steel clamps were made to fit the main cable. By means of an ingenious combination of three hoist lines stretched along the main cable, it required

only about 15 min. to move the cable clamp from one position to another. When this system was used at eight locations concurrently, a maximum of 22 sections was lifted and bolted into position in one day.

This method of erecting the suspended truss was also a novel feature which worked out satisfactorily as well as economically.

Before the concrete deck was poured, it was possible to rivet only the bottom chords of this truss. Since the true camber was established by this means, riveting of top chords and laterals was completed. Because of the accuracy with which the work was laid out in the shop, little or no reaming of the top chords was required after the deck was poured.

J. F. DUTHIE
President, Wallace Bridge and Structural Steel Company

Seattle, Wash.
November 2, 1931

Important Factors in Treating Irrigation Structures

TO THE EDITOR: In connection with Mr. Grant's interesting article in the September issue of CIVIL ENGINEERING, I should like to say that a number of factors influence the selection of material for irrigation structures. Perhaps one of the most important of these is the purely economic consideration of getting the greatest value for a dollar. This does not necessarily mean that the most economical structure is the one showing the lowest annual charge for the period of its use. For safety and security of service a more expensive structure may, in a certain situation, be desirable. On the other hand, experience shows that in developing a project substantial alterations are likely to be required, and the most economical structure may be one which shows the lowest annual cost over a period of five, ten, or fifteen years. A material giving a lower cost based on a longer period of use might be much more expensive.

For important structures, where a failure or interrupted or impaired service might cause substantial damage, the materials and design should be selected primarily with respect to durability and safety. With smaller and less important structures economy is more easily attained, although operating and climatic factors must also be considered. A system which has a non-operating frost-free period, when maintenance and replacement can be carried on advantageously, is most favorably situated. Under these circumstances, if the type, capacity, and location of the structure are fairly definitely established, it is easy to select materials for economy or expediency, without considering the period of usage. However, if the system is operated throughout the year, or if the canals and ditches are wet or frozen during the non-operating season, thus making maintenance and replacement difficult and expensive, a long period of usage is indicated as being economical.

What is the period of usage that might be expected of the various common construction materials? The answer depends on such factors as climate, soils, service, insects, bacteria, and fungi. I have seen concrete, metal flume sheets, and corrugated culverts completely disintegrate after a few years of service, while other parts of the same structures remained intact for a much longer period. Sometimes untreated wood structures have decayed in 4 years in light soil, although they can ordinarily be made to last 20 years by substantial maintenance on the more vulnerable parts.

Usually an irrigation structure is set in the ground, the bottom being buried more or less deeply in the soil and the top extending into the air. These differences in exposure in the same structure affect the rate of decay. The structure is most apt to decay at its point of contact with the surface of the ground on account of the variation in moisture and temperature conditions at this juncture. From the standpoint of economy, it would be ideal to use different materials for different parts of the structure, so that all of them would serve for the same period. To a limited extent this ideal can be, and often is, approached. I have, for instance, used lumber painted with, or dipped

TYPICAL DECAY IN AN UNTREATED WOOD TRESTLE AFTER 12 TO 15 YEARS OF SERVICE

in, creosote, or even pressure treated, in the more vulnerable parts of a structure and untreated lumber in other parts. To reduce local deterioration I have experimented with galvanized nails and have used timber piles and floors with walls and wings of concrete. However, except possibly in large structures, these principles are of limited application.

My personal experience with treated lumber for irrigation structures is not sufficient to justify me in expressing a definite opinion concerning its merits. I am doubtful whether brush-treated lumber has much to recommend it and I am not convinced that dipped lumber is ordinarily profitable. Of course if pressure-creosoted material has to be cut or bored, the raw surfaces should be hand-treated.

When possible, lumber should be cut to final dimensions before it is treated. However, where it is subject to abrasion or other mechanical deterioration, treatment may serve little or no purpose. On the whole, I believe that economy may best be obtained by the use of pressure-treated lumber wherever the desirable length of service of the structure approximates the probable period of its life.

AUGUSTUS GRIFFIN, M. Am. Soc. C.E.
Superintendent of Operation and Maintenance Eastern Section, Irrigation Block Department of Natural Resources

Brooks, Alberta
November 26, 1931

Novel Features in Suspension Bridges

DEAR SIR: The article by Dr. Steinman, in the September issue, presents many interesting features of the St. Johns suspension bridge.

The fact that the lateral pressure has been shown to have little effect on the physical properties of a twisted strand rope may be considered for increased span length of self-anchored suspension bridges. Moreover, the erection of twisted strand ropes for self-anchored bridges is

more convenient than spinning the parallel wire cables. An initial stretch in the twisted strands may be provided against by pre-stressing the rope and also by adjustment at the end sockets.

A pointed arch harmonizes well with the lightness of suspension bridges. The outline of such an arch usually gives an impression that the loads at the crown are much smaller than at the skewbacks. This effect is brought out in the tower above the roadway deck as a result of the concentration of cables at the tower columns.

Below the roadway deck in the St. Johns Bridge the frame above the pointed arch in the tower likewise creates the impression that the loads at the crown are insignificant. Also the pointed arches in the concrete piers of the approach spans would probably better harmonize with the main span if the frame or a recessed panel were placed above the arch. However, this bridge is a fine illustration of the fact that the improvement of methods of stress computations and advancement of the visible check tests of models offer great possibilities for the beautification of structures.

A. A. EREMIN, Assoc. M. Am. Soc. C.E.

Sacramento, Calif.
December 1, 1931

Technical Details of Lake Union Bridge

TO THE EDITOR: In connection with Mr. McCrory's article, "Lake Union Bridge Completed," in the September issue of CIVIL ENGINEERING, I should like to mention some points pertaining to details of design.

The final weights in the superstructure steel will show about 4,124 tons of structural silicon steel and 3,482 tons of structural carbon steel. Basic unit stresses in the carbon steel were 18,500 lb. per sq. in. in tension and $17{,}500 - 56\frac{l}{r}$ in compression. Unit stresses in the silicon steel, finally accepted under standard specifications for yield point, were 24,000 lb. per sq. in. in tension and $22{,}500 - 75\frac{l}{r}$ in compression. Various unit stresses used in detailing were in about the commonly accepted proportion to these basic units. In general, the permissible unit stresses in silicon steel were about one-third greater than the values for carbon steel.

Nearly all the material in the main truss members, excepting members of the 75-ft. spans, is silicon steel. Details are generally of carbon steel. The webs and flanges of all floor beams are of silicon steel, with details of carbon steel. Occasionally long-truss members under relatively low stresses were designed of carbon steel. The bracing members and flow stringers are of carbon steel.

The proportions of carbon and silicon steels in the different spans when completed are shown in Table I.

TABLE I. PROPORTIONS OF CARBON AND SILICON STEELS

SPANS	CARBON	SILICON
Three 75-ft. approach spans	0.90	0.10
200-ft. approach span	0.64	0.36
225-ft. approach span	0.59	0.41
150-ft. suspended span	0.70	0.30
South anchor (cantilever) span	0.39	0.61
North anchor (cantilever) span	0.39	0.61

In the steel superstructure contract there were 166 tons of steel castings, about 25 tons of steel forgings, and 2.13 tons of bronze in the form of linings at articulated bearing points.

All the rivets are of carbon rivet steel. After some consideration of this subject and of the results of shop tests on tapered and standard rivets, it was finally determined to use tapered rivets for grips exceeding 6 times the nominal diameter of the rivet. In detailing, standard rivets were used for grips up to 6 diameters, with an increase in the number of rivets used at the rate of 1 per cent for each $^1/_{16}$ in. of grip exceeding $4^1/_2$ rivet diameters. The maximum diameter of rivet used was $1^1/_4$ in., the tapered rivets being either $^7/_8$ in., 1 in., or $1^1/_4$ in. in diameter. The increase in nominal diameter for tapered rivets was about $^1/_{32}$ in.

Observations made in the field justified the selection of tapered rivets for long grips. They invariably indicated a better filling of holes. Perhaps fabricators are somewhat opposed to the use of such rivets on account of the variety of shapes demanded for the various grips. However, I believe these shapes could be simplified by the use of a constant length of taper equivalent to some multiple of the nominal diameter.

It may be remarked that K-type bracing was employed throughout all lateral and sway-frame systems. This was of material advantage in the elimination of the initial and indeterminate stresses that would have been expected in X-type bracing. Particularly on account of the deck design of the structure, the use of K-bracing here eliminated the extensive but uncertain direct stresses that X-bracing in the lateral systems would have taken in participation with truss chords under varying load conditions.

In order to minimize side flexure in floor beams, longitudinal direct stresses in stringers, and bending in stringer-connection angles, secondary expansion joints were provided in the floor system at intervals of 75 and 100 ft. (3 and 4 panels). At these points, the reinforced concrete roadway and sidewalk slabs have through copper-sealed expansion joints. At all panel points between main and secondary expansion joints, "dummy" copper-sealed joints have been placed in the floor slabs.

Piers are of reinforced concrete, with shafts cruciform in cross section. Although the reentrant faces of the shafts are in vertical planes, their outer faces are on curved tapers. In their construction no particular difficulty was experienced, and no costly form work was required.

R. M. MURRAY, M. Am. Soc. C.E.
Structural Engineer

Seattle, Wash.
November 26, 1931

Need for Development of Hydro-Electric Power

TO THE EDITOR: The symposium on "The Columbia River—for Irrigation and Power," in the September issue of CIVIL ENGINEERING, suggests several thoughts. For some years I have been in close touch with the work being done by the Army engineers and feel that their surveys embrace the greatest undeveloped resources in navigation, power, and reclamation in the United States. It is the consensus of such opinion as that of President Hoover, when Secretary of Commerce, of Elwood Mead, U.S. Commissioner of Reclamation, and of other eminent authorities, that the development of the Columbia River Project now being surveyed by the Army would double the population of the Northwest.

In the past 10 years, the State of California has had an increase in population of 2,000,000, while the increase for the State of Washington during the same period has been

only 204,000. One of the reasons for this is the fact that California, more than any other state, is harnessing hydro-electric power to make possible and feasible the development of its great projects. It is contemplating the total development of 2,800,000 hp. for aqueduct and reclamation projects. The first feature in connection with the building of the Los Angeles and Hetch Hetchy aqueducts was the construction of large power plants, and water power has also been utilized in connection with the reclamation of 876,000 acres of land in the state. The plans for the Great Valley Project, for the reclamation of between 14,000,000 and 15,000,000 acres of land, contemplate the utilization of 1,000,000 hp. At Hoover Dam an amount of power in excess of this figure will be developed, and contracts already made for this power will not only pay for the project but, in 50 years, will leave a surplus of $66,000,000.

In Mr. Tiffany's paper it is stated that the settler on irrigation projects can now stand a higher construction cost per acre than formerly because he has 40 years instead of 20 in which to make his payments. This statement is based upon the assumption that the Federal Government will waive interest charges. However, the serious question arises as to whether the Government will continue to provide this money without interest. It has done so in the past, because revenues for reclamation came mainly from the sale of public lands and oil leases in the West. But this source of revenue has gone. There is no money in the reclamation revolving fund for such a purpose, and it is doubtful if Congress will waive interest charges on the Columbia Basin Project.

We should face the fact that, on account of the high cost of construction, the Columbia Basin Project cannot be built without the utilization of large blocks of hydro-electric power. Ever since his visit to the Columbia Basin last August, Dr. Mead has been speaking of the necessity of developing hydro-electric power in connection with reclamation. Only recently he stated that within 20 years the major source of income on reclamation projects would be the power developed from them. Having complete faith in the ability and integrity of the Army engineers, I feel that they will utilize the vast power possibilities of the Grand Coulee Dam site on the Columbia River to make the basin project feasible.

JAMES O'SULLIVAN
Secretary, Columbia Valley Development League
Ephrata, Wash.
November 30, 1931

The Use of Treated Lumber in Irrigation Structures

TO THE EDITOR: The interesting article by Mr. Grant on "Treated Lumber for Irrigation Structures," in the September issue of CIVIL ENGINEERING, confirms my belief in the value of treated lumber as a construction material for use in all types of irrigation structures. Since the use of treated timber greatly reduces the extent and expense of repairs, the saving thus effected in maintenance more than balances the initial cost, which is greater than that for untreated lumber.

Modern timber preservation in this country may be said to date back to 1875, when a treating plant was erected at West Pascagoula, La. Treated lumber has been largely used by the railroads for some years, and about 17 years ago it was first employed for irrigation structures. Just recently it has been extensively used in highway construction. The established idea that steel and concrete constitute the only materials for durable construction is evidently being gradually overcome as the properties of treated timber are better known.

Economy is the primary consideration in the use of treated timber. Included in this are such items as first cost, length of life in service, cost of maintenance and replacement, interest on investment, and adaptability and flexibility. It is not the initial expenditure but the cost during a period of years that must be considered in any study of relative economy. In the desire to avoid high initial costs this fact is often overlooked. Treated timber retains all the advantages of the untreated product, such as ease of installation, transportation, and handling; installation with a minimum of equipment; and adaptability to local labor. The cost of treated timber is approximately double that of the untreated, but the cost of installation and maintenance differs only a little, and such difference as exists is usually in favor of the treated material. This, together with the greater period of service rendered by the treated lumber, makes its economy obvious.

On irrigation projects all structures can be divided into two general classes—conduits for the conveyance of water and those for its regulation and distribution. Conduits are of two types—pipe lines and flumes. Pipe lines are generally inverted siphons for the conveyance of water across depressions, but there is frequent occasion to use culverts for protection of the irrigation channels against local streams and for the conveyance of irrigation water under such structures, and under highways and railroads. Flumes are also used to convey water across depressions when the available head is fairly low or when soil conditions render necessary the protection of the channel against excessive erosion or seepage.

Several instances of service rendered by treated timber in pipe lines can be cited. A wood-stave inverted siphon of 60 and 63-in. diameter was installed across the Wenatchee River in 1915 for the Wenatchee Reclamation District. Pressure-treated, creosoted staves of Douglas Fir with a finished thickness of 2 in. were used. The siphon is in service from March 15 to November 1 of each year, and there has been no deterioration except a slight scour on the soft-grained staves in the bottom of the pipe within the first 500 ft. from the intake. Maintenance to date has consisted of the replacement of one stave in 1930.

Another wood-stave inverted siphon of 30-in diameter was installed across the same river in 1923 and 1924 for the Icicle Irrigation District. Pressure-treated creosoted staves of Douglas Fir, having a finished thickness of $1^1/_2$ in., were used for lower pressures, and the same, 2 in. thick, for higher pressures. Maximum pressure on the line is 280 ft., and maintenance to date has consisted of the replacement of two slash-grained staves.

A wood-stave pipe 12 in. in diameter was built for the conveyance of water to a condenser plant in Everett, Wash. This pipe was constructed in 1902 of pressure-treated creosoted staves of Douglas Fir. Service through the line is intermittent, but there has been no deterioration of the wood under the most severe operating conditions. Similar service records can be cited for semi-circular flumes of treated material wherever they are in use.

General experience with installations of box-type flumes and irrigation structures built of treated timber indicates that there is little or no maintenance cost on these and an expectancy of service that can safely be assumed to exceed 30 years. In irrigation practice the use of treated material for structures other than the pipe lines of flumes has been slow to develop, chiefly because untreated timber is relatively low in cost, can be framed on the job, and only a general stock of standard dimen-

sions need be maintained as a supply. An adequate pressure treatment of timber costs an appreciable amount. To secure full returns from this cost, the material should be pre-framed, thereby avoiding the exposure of untreated surfaces such as would occur in treated timber framed on the job. Then, too, the pre-framing itself has possible economies because it can be done at or near the treating plant, where the use of machinery saves labor in framing and waste in cutting, and reduces the weight and bulk, with a consequent saving in freight and handling.

JOHN G. HEINZ, M. Am. Soc. C.E.

Tacoma, Wash.
November 29, 1931

Planetary Influences on Drought Periods

DEAR SIR: The article by Mr. Hoyt on "National Aspects of the Drought," in the October issue, contains valuable data and much that is of interest and profit. Officials of the Weather Bureau point out that the immediate cause of droughts is not sun spots but a lack of air currents from Arctic regions to cool the air and facilitate precipitation. Stagnation of the upper air is then the real cause of droughts, and to understand this it is necessary to understand the cause of currents in the earth's atmosphere.

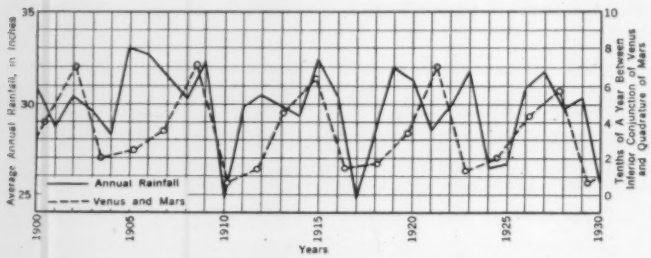


FIG. 1. PLANETARY INFLUENCE ON AVERAGE ANNUAL PRECIPITATION IN THE UNITED STATES

From an engineering point of view, it seems to me that the movements of the earth's atmosphere can be accounted for only by the assumption that the cause is extra-terrestrial. However, the influence of the sun is by no means an adequate explanation although it doubtless causes high convection currents due to tropical heat, which flow toward the polar regions, and low air currents blowing toward the tropics. When the great volcano Krakatoa erupted in 1883, it was discovered that there was a continuous circulation of air in the tropical belt moving eastward at hurricane velocity many miles above the earth's surface. The rotation of the earth cannot account for this. Gravitation and the centrifugal force of the earth-sun and the earth-moon combinations are responsible for it, as they are for the tides and the ocean currents.

In the TRANSACTIONS of the Society, for 1928, Vol. 92, page 680, I showed—by means of a chart extending over a period of 80 years—the remarkable agreement between line-ups of Jupiter and Venus and the earth, and sun spot counts. This same agreement is true for 300 years, the entire time in which sun spots have been observed and counted.

The earth's air drifts are affected not only by the moon and the sun but also by the near planets, especially Venus and Mars. The theory of this influence will not be given here. It is enough to say that when these two planets are in quadrature, their influence in augmenting the earth's air currents is nullified. Thus periods of comparative drought can be expected when these planets are in quadrature.

A chart published on page 238 of *Engineering News-Record* for February 5, 1931, shows the average rainfall for a number of cities in the United States for the period from 1904 to 1930. On this chart, Fig. 1, I have charted points connected by broken lines to indicate the times when Mars and Venus were near quadrature, with Venus nearest the earth or in inferior conjunction. These intervals are thus shown to closely coincide with the drought years for this period. It is interesting to note that there are four intervals of 6.5 years between exceptionally dry periods in the years under observation and that Mars and Venus follow practically the same cycle in their relative positions every 6.4 years.

When it is realized that the influence of these planets on the earth's atmosphere is subordinate to the regular influence of the sun and moon and not a primary influence, the agreement of the locus showing the subordinate cause of air stagnation and the rainfall actually observed can scarcely be classed as accidental. It must be remembered that the influences of the sun and moon are subject to many variations. In several instances the flow of the Potomac River, as recorded by Mr. Hoyt, shows drought peaks that agree with the accompanying chart.

It seems to me that engineers can study with profit the great perpetual motion engines of the solar system. Astronomers have overlooked the fact that although gravitation and centrifugal force balance such bodies as planets, comets, and the sun, they have varying intensities, which obey different laws. This accounts for the strains and fluid flow that practically explain the mystery of heat creation as well as natural electrical phenomena.

A few wet years may be expected in the near future, and there will probably be a dry year about 1936.

EDWARD GODFREY, M. Am. Soc. C.E
Structural Engineer

Pittsburgh, Pa.
December 1, 1931

Merit in Latin-American Syndicate Idea

TO THE EDITOR: The plan suggested in the November number for a Latin-American syndicate would, if properly executed, provide a needed and worthwhile service. The great natural resources of South and Central America need capital for development. The growth and modernization of this vast territory will involve major problems requiring a high quality of engineering for their satisfactory solution.

It is no secret that North American engineers have long sought to break through the barriers of Latin-American reserve and mistrust, in an endeavor to secure some of the larger construction projects. Among these are large organizations of wide reputation, some of which can command ample financial backing. Much of this effort has been without success, due doubtless to excessive costs in making contacts and obtaining contracts, to unsatisfactory conditions imposed by governmental or political requirements, and to lack of assurance as to the final issue. A syndicate specially organized for this purpose would be better equipped to cope with these difficulties.

While Latin Americans have in the past drawn largely on our technical skill and Yankee enterprise for accomplishing things, and have borrowed heavily from us, they have recently, to a certain extent, been developing their own capacity along these lines. Not only have their

young men been attending technical schools but they are also discovering that public works may be financed at home. Venezuela, for instance, has a department of public works which handles all the government engineering and construction work, and seeks no outside aid in financing it. Haiti has been developing such a public works department under the guidance of the United States Navy and is now anxious to replace all American workers by natives. This tendency exists in many of the Latin-American republics. Political considerations are not less pressing in these countries than in our own, and we must expect a certain aloofness to a proposal of the kind suggested by Dr. Waddell, however altruistic the plan.

Only meritorious projects should be undertaken, and then only when it can be shown that the benefits will exceed the cost. The organization must be self sustaining; it must sell its service and enlist cooperation before profits can be realized, all of which will require the investment of capital. Such a program will require intensive and sustained effort to make projects available.

In sizing up possibilities even the wisest engineer cannot always discern readily between the profitable and unprofitable. The rejection of an unsound scheme may constitute a greater public service than the successful execution of a beneficial project. The preliminary work required to prove a project unsound may be costly, and the justification of such expense is not always easy. Some possibilities are not discovered until they have had considerable publicity, and the rejection of a prospect that has become a definite picture in the public mind may be unpopular business—so much so in fact that the reputation of the engineer has not always been able to survive the strain. The type of organization suggested for this Latin-American syndicate would, perhaps more than any other agency, be able to maintain its stability and integrity in all situations.

It may be argued that the time is inopportune for launching a new enterprise, but I am rather inclined to the theory that a good time to lay the foundations of a new business is when conditions are bad. If the syndicate can be successfully sold to Latin America under present conditions, it should have a fair chance of success. Dr. Waddell presents an alluring prospect. An attempt to focus on a given project the highest degree of engineering skill and maturity of judgment seems thoroughly worth while.

C. A. BOCK, M. Am. Soc. C.E.
Vice-President, The Dayton Morgan Engineering Company

Dayton, Ohio
November 28, 1931

Financing Latin-American Projects

DEAR SIR: Apropos of Dr. Waddell's suggestion in the November issue, methods customary in this country for promoting and financing projects, for providing engineering services, and for arranging construction contracts are generally not applicable in Latin-American countries, particularly in the less highly developed ones. A syndicate of the character suggested, under competent direction and leadership, adequately financed, would certainly have opportunities which are denied to the individual engineer or contractor. Management and operation, at least of a closely supervisory character, of completed projects are generally required, and undoubtedly Dr. Waddell has that in mind.

Of course, such enterprises must hold the promise of more than usual return to attract capital. Investors naturally prefer to have their capital in their own country or where conditions and laws are familiar and where the government seems permanent. The provision of adequate preliminary funds for exploration, investigation, and selection of meritorious projects is, of course, essential to the program outlined.

It might be simpler to select competent engineers and contractors, or even competent representatives, to deal with governments or other public bodies, than to provide for the financing of such projects.

However, British exploration and promotion companies, perhaps less highly organized in their inception than that now proposed, have constructed many important works in foreign lands. The profession will observe with interest the successful culmination of Dr. Waddell's project.

ERNEST E. HOWARD, M. Am. Soc. C.E.
Consulting Engineer

Kansas City, Mo.
November 25, 1931

Advice to Bankers Needed, Not Construction in Latin America

TO THE EDITOR: Discussion of Dr. Waddell's plan for developing the latent resources of Latin America, as proposed in his letter in the November number, will be valuable in bringing out different points of view, from which a conclusion worthy of adoption may follow. Notwithstanding my sympathy with projects for the development of the countries to the south of us, in which I was engaged for some years, I am not convinced of the timeliness or necessity of his proposal.

At present there is an overabundance of practically everything that these countries produce, whether minerals, such as copper, lead, manganese, petroleum, silver, tin, and zinc; or agricultural products, such as bananas, coffee, cotton, and sugar. This overdevelopment also obtains in the case of railways and public utilities. Then, too, the obligations of Latin-American governments and enterprises are now selling at such low prices as to discourage further investment. It would therefore seem that some years must elapse before there will be a place for such an organization as that visualized by Dr. Waddell.

In any event, I doubt the necessity of it. In the past there has been little difficulty in finding either in the Latin-American countries themselves or in foreign lands the necessary skill and capital to develop these resources. American corporations have been prominent in winning and placing on the markets of the world the mineral and agricultural products already named. Americans have also done their part in the development of public utilities, and in the construction of railways, highways, and other public works. It is therefore safe to assume that the resources and public works of these countries will be properly taken care of by organizations already in the field or by those who are interested in similar enterprises elsewhere.

There is, however, a field in which engineers can be of service to these countries and to American investors. During the past ten years our bankers have bid against each other for the privilege of lending money to Latin-American governments (Federal, state, and city) with the intention of selling the resultant obligations, regardless apparently of their intrinsic value, as long as they were salable—which they readily were during the recent

period. Although the bankers consulted lawyers as to the legality of these obligations, they made no serious investigations of the economic value of the enterprises for which bonds were issued. In some instances the proceeds were diverted from the purpose for which the money was ostensibly raised.

With proper engineering investigation and supervision many of these countries would not now be burdened with bonds issued for works of little benefit. There is no doubt that certain governments would have welcomed competent engineering advice, which would have helped them to resist the demands of politicians to construct only works of local importance. The practice of "log rolling" is not confined entirely to the politicians of our own country.

If Dr. Waddell, with his well known initiative, energy, and resourcefulness, would make an effort to convince our bankers of the service which competent engineers could render to borrowing nations and corporations, as well as to American investors, I believe he would accomplish more just now than by forming his proposed syndicate, which could be postponed to a more propitious season.

PHILIP W. HENRY, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
December 9, 1931

Increasing Undergraduate Engineering Efficiency

TO THE EDITOR: The larger part of Mr. Hammond's article on the education of the civil engineer, in the November issue, paints an essentially accurate picture of engineering education today, and it is to be hoped that the article will stimulate greater interest in this branch of education. However, the conclusions which Mr. Hammond draws seem too optimistic.

He makes a lamentable mistake when he compares the work of our engineering schools with other divisions of undergraduate work. The engineering school is a professional school, and it may properly be compared with other professional schools, such as schools of medicine or of law. It is hard to compare the standards of an "average" school of engineering with those of an "average" school of medicine, for example; but the best schools of each may be compared, and to one who can make the comparison dispassionately, the schools of medicine must appear considerably more advanced than those of engineering.

There can be no doubt in the minds of serious teachers of engineering subjects that the curriculum is terribly overcrowded. The amount of work required of engineering students is easily 25 per cent more than that required of students in the liberal arts. To say that the work is more difficult, however, is not fair. The tendency is to simplify the work of the student of engineering as much as possible because he has five years' work to do in four. This race against time results in the student's receiving a smattering of physics, mathematics, and chemistry, followed by such courses as thermodynamics and mechanics taught as engineering subjects. Rarely are the required courses in these subjects thorough; they cannot be. The schools of engineering need six years for proper training of the students instead of four years; many of them are succeeding in a fashion in teaching five years' work in the allotted four. Naturally, as Mr. Hammond intimates, the results are no better than might be expected.

Mr. Hammond appears to imply that it is a creditable thing that a considerable proportion of engineering students are largely dependent on themselves for support during college. It is true that it is very much to the credit of these students that they are willing to work so hard, but most of them are unknowingly attempting the impossible. Their training becomes even more superficial than that of comparable students who are not handicapped in the same way.

The inadequate preparation of faculty members for pursuing their calling is another burden under which engineering education is laboring. According to Mr. Hammond only about one-fifth of the faculty members hold the doctor's or the master's degree, and only about one-twentieth hold the doctor's degree. In other words, most of them are trying to teach subjects in which their preparation is little better than undergraduate training. Their contacts with the practical world of engineering are, of course, advantageous, but teachers will learn little in practice that can be taught with profit. The things which should be taught are the things the student can only with difficulty learn later. The student cannot help but learn practical matters as soon as he leaves school. It is true, as Mr. Hammond says, that the holding of higher degrees should not be made the criterion on which to base advancement; but it should be taken into account, and the doctor's degree should receive far more respect among engineers than it has received in the past.

An adequate number of the sub-collegiate institutions mentioned by Mr. Hammond, to prepare men for subordinate positions, would relieve the higher schools of an immense amount of dead material which at present hampers them immeasurably. If nine-tenths of the present schools of engineering concentrated on training men for the minor positions and the other one-tenth adopted a six-year course, there would be far fewer disappointments and disillusionments in the years after graduation.

WILLIAM R. OSGOOD, Assoc. M. Am. Soc. C.E.
Engineer, U.S. Bureau of Standards

Washington, D.C.
November 23, 1931

New Methods of Consolidating Foundations

TO THE EDITOR: Mr. Carver's article in the September issue prompts me to make a few remarks suggested by his reference to the Diablo Dam.

The most difficult part of the work on this dam was the construction of the two cofferdams. The overburden was about 50 ft. deep. A row of steel sheet piles was driven across the river, but on account of the presence of boulders the piles did not go very deep before they bent over. No fines were available to stop the leakage, so it was attempted to cement grout the fills.

The experience from elsewhere was repeated here; the cement grout could not be forced more than a few inches away from the grout pipe. The fills could not be made water-tight, and it took at times seven pumps to keep the excavation unwatered.

Such a condition does not need to prevail any longer. Dr. Ing H. Joosten, a German engineer, has invented a solidification process by means of which it is possible to solidify sand, gravel, loose material, poor rock, and poor concrete by the injection of two cheap chemicals under pressure. The chemicals, unlike cement grout, have no particles floating in them and the distance of penetration

depends only upon the coarseness of the material and the pressure used.

This process has been extensively used in Germany for the last two years and is about to be introduced in this country. Sodium silicate is first forced by means of pressure pumps through perforated pipes, followed by a second chemical with which it forms a gel and glues the particles together. A water-tight mass is formed, which after a short time will have a compressive strength of from about 1,200 to 1,400 lb. per sq. in. for coarse gravel; for fine silt the compressive strength will be about 250 lb. per sq. in. Clay cannot be solidified by this method since there are no pores into which the chemicals can penetrate.

The solidified product is water-tight and insoluble. The process can, of course, be used for many other purposes than for water-tight cores in dams. In Germany it has been used for building foundations, for bridge pier foundations, and for repairing tunnel and shaft linings, also for solidifying poor ground ahead of tunnel excavations to avoid cave-ins and water leaks.

Where alternate strata of soft clay, sand, and gravel are present under a proposed building, concrete piles are driven through several of the strata, whereupon all the sand and gravel strata are solidified by means of the injection of the two chemicals. For grouting cracks in rock or contraction joints, it is sometimes of advantage to follow up the chemicals with a grout made of very finely ground cement; the chemicals furnish the lubrication and the grout the strength.

If a sack of cement costs 57 cents, the cost of the chemicals for filling the same amount of voids will be the same, at least as a rough approximation. The chemical solidification is in no way intended as a substitute for concrete, but has a field of its own. For making cut-off walls across a river bed or the like, the cost per unit volume will depend, of course, upon the amount of boulders encountered. These will have to be drilled before the grout pipe can be inserted, but there is hardly any other way a water-tight cut-off reaching to bedrock can be made.

I believe this method will be an important factor in the construction industry in the future.

LARS JORGENSEN, M. Am. Soc. C.E.
Consulting Hydro-Electric Engineer

San Francisco, Calif.
November 5, 1931

Important Aspects of Upper Mississippi Survey

TO THE EDITOR: In his article in the December issue, Mr. Ylvisaker has prepared a complete report of the general procedure adopted in the preparation of the Upper Mississippi survey. It might be advisable to discuss at greater length some of the details of the survey.

The additional areas valuable for orientation, which lay adjacent to the river plain but more than 10 ft. above high water, were not fully mapped. The airplane photographs naturally covered these areas. All that was required for orientation purposes was to place roads and railroads in this territory on the field sheets. This was accomplished directly by restitution from the photographs. The cost was negligible, and with the roads and railroads thus made continuous, it is possible to use the map for general purposes. If the roads and railroads above high water had been omitted, such use would be impossible.

After the supplemental agreements had been accomplished, a contoured map was available for the area above Burlington, Iowa, and when the additional topography between levees below Keokuk is finished, a contour map will be available for the whole upper valley, except along the shores of Lake Cooper (or Keokuk), where there is almost no variation between high and low water. Here a map without contours will suffice. As Mr. Ylvisaker has stated, this map will be available for many purposes other than the preparation of plans for canalization.

The soundings were referenced to sea level, instead of to an arbitrary low-water plane. This will greatly facilitate future study of hydrography, especially if subsurface conditions are later altered by locks and dams. The elevation above mean sea level of the low water of 1930, was, however, carefully determined; and both known and interpolated elevations were shown on the map. An appropriate symbol discriminates between the two types of elevation.

There has been some professional discussion as to the relative advisability of contact and force account surveying. Under the circumstances obtaining in 1929 rapid surveying on the Upper Mississippi was imperatively required, since the board appointed by the Chief of Engineers, U.S. Army, was ordered to expedite its report. Adequate survey parties, with untried personnel, could not have been mobilized to do the work in time without running grave risk of inaccuracies. A contract for surveying was thus unavoidable.

Of course systematic inspection can diminish surveying errors, but the real protection consists in work which would be first class even if there were no inspection. The contractor on the Upper Mississippi survey was an engineer of the highest type, and his careful supervision was the best guarantee of an accurate map. It is, of course, possible that less hurried work done by a carefully recruited Government force might have resulted in lower unit costs, but it would not, it is thought, have produced a better map. On the other hand, if a contractor with less professional pride had been chosen, an enormous amount of inspection would have been needed; resurveys would have consumed valuable time; and even then confidence in the map would have been wanting.

One feature of the Upper Mississippi survey should be noted by topographical engineers. Every engineering monument discovered in the area surveyed, or immediately adjacent to it, is shown on the map, and a table is printed on each sheet showing the horizontal and vertical coordinates of these monuments, wherever they could be ascertained. Where they could not be ascertained from a study of previous surveys, they were tied in by level lines and their type and vertical coordinates noted. New monuments placed in connection with the survey, or with the contemporaneous surveys of projected lock sites, were similarly shown. No monuments were shown which could not be located. As long as the monuments now in existence endure, the map and the terrain will be tied to each other. Any engineer experienced in topography will recall old maps, sometimes both accurate and expensive, whose utility has been completely destroyed by failure to take this precaution.

In concluding this discussion, reference may properly be made to the uncomfortable and highly variable climatic conditions to be encounted in an all-year survey of the Upper Mississippi, and to the cheerfulness displayed by all concerned in overcoming these conditions.

C. L. HALL, M. Am. Soc. C.E.
Lieutenant-Colonel Corps of Engineers

West Point, N.Y.
December 5, 1931

Tax Burdens Do Not Bring Prosperity

DEAR SIR: Although many points made by Mr. Grunsky in his article, "The Way to National Progress and Prosperity," in the October issue of CIVIL ENGINEERING, may be correct, there are two which appear fallacious. In his statement that "Objection should not be made to the magnitude of the sum to be raised, but to the prevailing unfair systems of apportioning the tax," he is speaking of the sources of the money which the Government spends. He may be correct in saying that the distribution of the tax burden is not equitable, but there is no chance in the world of ever satisfying the human race on the subject of distribution of the tax burden. The millenium must come first. This problem has confronted governments since the establishment of the first one and will continue to be perplexing until the last government.

Possibly Mr. Grunsky has been influenced by recent complaints that real estate is carrying an undue burden of taxation. But is it? The data given in Table I indicate that there are sources of revenue other than general property. The burden which the real estate people have generally advertised as the correct figure does not compare with the figures given in this table.

TABLE I. SOURCES OF $100 OF REVENUE OF FEDERAL, STATE, AND LOCAL GOVERNMENTS

VARIABLE	FEDERAL	STATE	LOCAL	TOTAL
Taxes:				
On income	$16.33	$0.26	$0.67	$17.26
On general property	...	3.32	32.60	35.92
On business	2.29	3.12	1.69	7.10
On consumption	3.95	2.65	0.32	7.00
On privilege	0.43	0.12	0.57	1.04
On inheritances	1.01	0.80	0.03	1.84
Customs duties	5.09	...	...	5.09
Assessments for benefits and services	0.23	0.29	3.76	4.28
Fines and forfeits	0.11	0.07	0.36	0.54
Subventions and gifts	0.06	1.20	2.20	3.46
Trust funds	0.78	0.13	0.40	1.31
Rent	0.10	0.10	0.44	0.64
Interest	1.65	0.52	1.50	3.67
Sale of property	2.02	...	...	2.02
Earnings of departments	0.52	1.10	1.36	2.98
Earnings of public service enterprises	0.23	0.09	5.26	5.58
Miscellaneous receipts	0.27	...	...	0.27
Total	$35.07	$13.77	$51.16	$100.00

The totals of governmental revenues are reduced in this table to proportionate parts of $100. Prepared especially for *Nation's Business*, January 1929, it provides the first instance in which these quantities have been so related as to give a bird's-eye view of the system by which all units of government—Federal, state, and local—obtain their revenues.

I am afraid that the way to national progress and prosperity desired by Mr. Grunsky will not result from an attempt to redistribute our tax burden. The problem itself is more complex than that of increasing national prosperity.

The second of Mr. Grunsky's points to which issue can be taken is doubly fallacious. First, he says that there would be less dissatisfaction if the burden of taxation were equitably distributed. No support can be given to such a statement as this. One needs only to look at history to see the answer.

Another fallacy is that the greater the tax the less the slump in the aggregate volume of the country's business. If this statement is true, why are many other countries more severly affected by the depression than we are, when these countries have double or three times as high a rate of taxation as ourselves? If Mr. Grunsky's statement is carried to its logical conclusion, then 100 per cent of one's income should go to the Government so as to maintain prosperity. I am wondering if Mr. Grunsky advocates the complete ownership by the Government of all property, of all income, and of the bodies and souls of its citizens?

HAROLD A. STONE, Assoc. M. Am. Soc. C.E.
Director of Research, California Taxpayers' Association

Los Angeles, Calif.
November 21, 1931

Planning Ahead Necessary in Successful Bridge Clearance

TO THE EDITOR: I should like to say at the outset of this discussion of Mr. Coleman's article on "Bridge Clearances Over Navigable Waterways," in the December issue, that my comments express my own personal views on the subject—drawn from my own experience—and that I am not writing in the capacity of authorized spokesman for the Chief of Engineers or the War Department. Mr. Coleman's paper is a full and fair statement of the problem. He approaches the subject with a broad and sympathetic understanding of the conflicting interests involved. Under his impartial guidance I am convinced that his committee will produce a report which will be a timely and valuable contribution to the solution of the problem.

Pioneers penetrated our vast inland domain by following the navigable waterways, and a basic law has carefully preserved these water paths back to the sea—as rights-of-way for trade and travel. But with the advance of civilization, of course it was found necessary to cross these rights-of-way by other means than boats. Our courts, in the interests of the public, early decided that the people had a right to cross a stream by bridge just as they had a right to use the stream, but always in a manner to preserve the water right-of-way.

From the point of view of one primarily interested in land transport, a river is but an obstruction to be crossed as conveniently and economically as possible. On the other hand, the man who conducts a transportation business on the water is interested in seeing to it that as few obstructions are placed in the stream as possible. He wants those that are necessary placed with great care so that there may not be an unreasonable obstruction to free, easy, and profitable navigation.

These points of view are far apart. Public interest demands that they be reconciled, and they can be reconciled, if only we will take the time and patience to solve the problem as we would any other engineering problem.

It is my experience that mistakes occur through too little consideration and too little planning. All of us in this country have heretofore been too undermanned in our engineering forces to permit of planning ahead. However, even when the planning ahead is possible, highway departments or railroads all too often go ahead alone with their plans for several years and when the landside of the problem is fixed and unchangeable, they come to us for the approval of plans for the bridge, located perhaps at the worst bend in the stream, and then complain at our insistence on what they feel are unreasonably wide spans.

Why not come to us early?

GEORGE R. SPALDING
Colonel, Corps of Engineers, U.S.A.

St. Louis, Mo.
December 6, 1931

Present Bridge-Clearance Requirements Unreasonable

TO THE EDITOR: In connection with Mr. Coleman's article on "Bridge Clearances Over Navigable Waterways," in the December issue, I should like to mention a few cases where waste could have been avoided in the construction of bridges over rivers classed as navigable, although not used by commercial vessels, if the regulations of the War Department for the protection of possible future navigation had not prevented.

Of the larger rivers of the Northwest that were once navigated, the Upper Mississippi (above St. Paul), the Missouri, Yellowstone, Red River of the North, Pend Oreille, and Upper Columbia now carry no commercial navigation because of competition by the cheaper methods of land transportation. Since these streams are theoretically navigable, the cost of construction of bridge crossings has been greater than the income from river traffic. Of the nineteen crossings of navigable waterways on the Great Northern Railway within the United States, where drawbridges were once required, nine cross streams where there is now no commercial navigation.

Three examples of waste in railway bridge construction as a result of too restrictive regulations are given as follows:

First, the Great Northern Railway bridge across the Missouri River near Snowden, Mont., was erected in 1913 and a 296-ft. lift span was required for protection of river navigation. This navigation has been non-existent during the eighteen years since the erection of the bridge, and the lift span has never been raised except for a Government snag-pulling boat or for a Government inspection.

Second, the Government requirements as to the Great Northern Railway bridge across the Yellowstone River near Fairview, Mont., were not only that the bridge should contain a movable span but also that it should cross the river at such an angle that a tunnel 1,455 ft. long was made necessary. The added expense was $225,000. No commercial vessels have passed under this bridge during the eighteen years it has been in existence.

Third, near Harrisburg, Ore., both the Southern Pacific and the Oregon Electric Railway cross the upper water of the Willamette River—a theoretically navigable stream. The bridge crossing of the Oregon Electric Railway is downstream only a few hundred feet from that of the Southern Pacific, which is older. The latter has a movable span under which a bar formed which prevents the passage of any boat. When the Oregon Electric built its line it was required to place a movable span in its bridge across the new channel. Because of the angle between the draws in the two bridges, navigation would be impossible even though a channel were excavated under the Southern Pacific draw.

While these examples are taken from railway experience and there is little likelihood of extensive construction of railways across navigable rivers in the future, there is—particularly in the Northwest—the problem of building highways across so-called navigable streams. The highway systems of our Western states are far from complete. Until five years ago there were no highway bridges across the Missouri River between Bismarck, N.D., and Great Falls, Mont., a distance of more than 500 miles. Since then three bridges have been built, and the Snowden Bridge of the Great Northern Railway has been planked for highway traffic. Additional bridges are also being planned.

Requirements call for a 38-ft. clearance above high water, while a 10 or 15-ft. clearance would meet the present needs. All such clearance restrictions add materially to Federal, state, and county taxes. It becomes a matter of moment to each of us as to whether it is worth while to spend the additional money necessary for clearance of vessels in order to preserve the potentiality of navigation, which is not now a reality. At present it would certainly seem proper to require only a 10 or 15-ft. vertical clearance, and in the improbable event of an increase in navigation the bridges could be so changed as to provide the greater clearance.

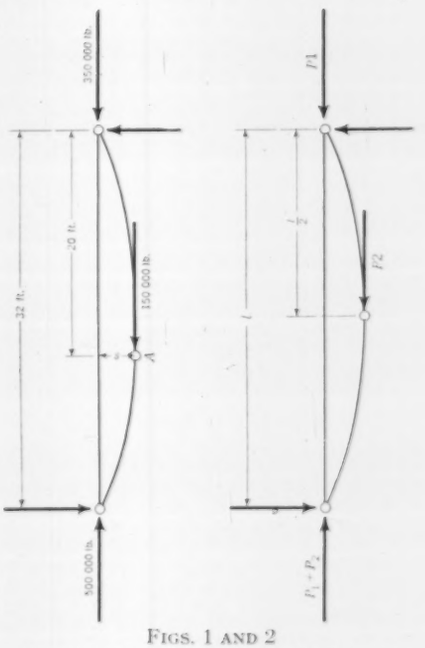
A complete study of the situation of bridge clearance requirements such as is now being undertaken by the War Department and by the committee of the Engineering-Economics and Finance Division of the Society should tend to correct regulations, which in the past have resulted in great lack of economy, in order to protect non-existent water transportation at the expense of land transportation.

HENRY K. DOUGAN, M. Am. Soc. C.E.
Executive Assistant, Great Northern Railway, St. Paul

St. Paul, Minn.
December 7, 1931.

Column Design with Intermediate Loads

DEAR SIR: In a letter published in the September issue, Mr. Downey inquires about the correct way of designing a column loaded at the top and also at an intermediate point without being supported at this point. While it is always safe to design a column of this type for the full load applied at the top, a saving is sometimes made possible by a more exact analysis. For columns hinged at both ends, it is possible to obtain an approximate idea of the saving by the following simple reasoning.



FIGS. 1 AND 2
COLUMNS WITH INTERMEDIATE LOADS

A column may fail in one of two ways—either by flexure or by crushing. In general, long and slender columns will fail by flexure, while those that are short and heavy will fail by crushing. To be safe, a column must have an ample factor of safety against failure in either way. Safety against flexure will determine its moment of inertia, and safety against crushing its area. To overcome the inconvenience of having to use two formulas for the design of each column empirical formulas have been worked out in great numbers which, supposedly, give the desired safety against failure by either flexure or crushing.

These formulas have the weakness inherent in all

empirical formulas in that they apply only to the case for which they were established—namely, loading at the top only—which accounts for Mr. Downey's predicament. The problem of flexure of columns was solved some 175 years ago by Euler and Lagrange (*Memoirs de l'Academie de Berlin*, 1757), who determined the "critical load" for a column by the following formula:

$$P = \frac{\pi^2 EI}{l^2} \quad \ldots\ldots\ldots [1]$$

Where E is the elastic modulus, I the (least) moment of inertia, and l the length, the column is assumed hinged at both ends. This formula does not contain the cross sectional area, nor does it say anything about the unit stress. It deals with flexure only, and its correctness has been proved by innumerable tests.

To give a simple method for comparing the column loading suggested by Mr. Downey with the standard case of loading at the top only, let the column, Fig. 1, be given an arbitrary deflection, which at point A amounts to S. The bending moment at A, with 350,000 lb. at the top and 150,000 lb. at A, will then be:

$$M_1 = 350{,}000 \times S + 150{,}000 \frac{S}{32} \times 20$$
$$= 440{,}000 \times S.$$

With all the load at the top the bending moment would be $M_2 = 500{,}000\ S$.

If the two moment curves were proportionate at all points in the ratio $\frac{444}{500}$, and if 500,000 lb. were the critical load applied at the top, $\frac{500}{444} \times 350{,}000$ and $\frac{500}{444} \times 150{,}000$ would be the critical loads applied in the manner shown in Fig. 1.

Equation 1 may be rearranged as: $I_2 = n \frac{Pl^2}{\pi^2 E}$, where I_2 is the required moment of inertia for a desired safety factor n. With a load distribution, as shown in Fig. 1, the required moment of inertia would be:

$$I_1 = \frac{444}{500} I_2 = 0.89\ I_2$$

It should be noted that the purpose of this reasoning is to obtain an idea of the magnitude of the change in the required moment of inertia due to the shifting of part of the load to a point further down the column. It should not be used for direct design as it may give very erroneous results in special cases.

For a column supporting a load P_1 at the top and P_2 at the midpoint the formula (Fig. 2) becomes:

$$\frac{I_1}{I_2} = \frac{P_1 + \frac{1}{2} P_2}{P_1 + P_2}, \text{ or}$$

$$I_1 = n \frac{\left(P_1 + \frac{P_2}{2}\right) l^2}{\pi^2 E}$$

This formula gives very good values at least for

$$0 < \frac{P_2}{P_1} < 2.$$

If it is decided that the possible saving in moment of inertia, not necessarily in area and weight, is worth a further investigation, exact formulas for the case given by Mr. Downey may be obtained from a paper by Jasinski (*Annales des Ponts et Chaussees*, 1894, Vol. 2, page 233), providing the ends of the column are free to rotate. The formulas should be used with caution as there are many misprints.

If the column is restrained at the base a very useful, but almost forgotten, method of approach has been suggested by Vianello in *Zeitschrift des Vereines deutscher Ingenieure*, 1898, Vol. 42, page 1436.

C. P. VETTER, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Pacific Gas and Electric Company
San Francisco, Calif.
November 28, 1931

Latin America—A Fertile Field

TO THE EDITOR: The suggestion of J. A. L. Waddell, in the November number, regarding the formation of a Latin-American syndicate comes at an opportune time.

Latin America is peculiarly a proper field for American endeavor and for American capital seeking productive employment. South America is not only a heavy producer of raw materials required by us, but in normal times is also a large consumer of our manufactured articles. The annual business between the United States and South America has reached the stupendous sum of two billion dollars, which is about one-fifth of our foreign commerce; and our investments in the whole of Latin America aggregate nearly six billion dollars, equivalent to about one-third of our total foreign investments.

While some American concerns have been active there for many years, it is safe to say that, viewed from the standpoint of ultimate possibilities, they have scarcely scratched the surface. For example, it may be surprising to learn that in many places raw material is still transported by men as carriers of burden, on mule back, or in ox carts. Even though wages are low, the cost of transportation from the source to an ocean port is often greater than the cost of ocean transport to this country and, in numerous instances, it exceeds the cost of the product itself.

Since transportation is so vital an element in industrial development and in the maintenance of commerce, the great need for adequate and modern transportation facilities is apparent. The development of these facilities should proceed in conformity with some well conceived and unified plan for the commercial development of the country as a whole.

Some of the reasons why the development of Latin America has been slow are undoubtedly to be found in the attitude of the native population toward foreign enterprises and in our own lack of understanding of Latin-American culture and psychology. The climate, instability of local governments, certain nationalistic laws unfavorable to foreign capital, and the imposition of extremely high taxes—not to mention the element of personal insecurity in certain sections—have also contributed to retard proper development in the past. Highly trained men of understanding, appreciation, and leadership can effect a vast change in these conditions that will be of mutual benefit.

Latin America has unlimited quantities of food products and raw materials which are urgently needed by every civilized nation on the face of the globe. The need for these will be particularly felt as soon as the world returns to normalcy.

The task of adequately developing transportation arteries and of bringing to light the vast treasures now lying dormant in the soil of these Latin-American countries, is a huge one. Concerted effort in nearly every branch of endeavor will be required and extreme care will have to be exercised in the selection of the men called upon to visualize and plan such a development.

Viewed from every possible angle, one cannot help but feel that the present is the most opportune time for organizing such a syndicate. Considerable time will be required to go through the formative stages and to lay the necessary groundwork that would enable such an organization to function properly. It is quite evident also that a vast amount of work will have to be done in Latin America during the next few decades and that a well organized syndicate should have little difficulty in promoting enterprises that would be of great benefit to the countries served and that would yield a reasonable profit to the organization doing the work.

L. A. JENNY, M. Am Soc. C.E.
Consulting Engineer, Eppler, Botz, and Sangster

New York, N.Y.
December 1, 1931

No Patronizing of South Americans

DEAR SIR: I have read with considerable interest the plan for a Latin-American engineering and construction enterprise outlined by Dr. Waddell in the November issue. This plan undoubtedly has merit. However, I believe the matter should be undertaken in a slightly different spirit from that indicated. It should be offered with the idea of mutual assistance and not with the appearance that we are doing something for our "less fortunate neighbors." Also, I believe that the syndicate should include three or four prominent South American engineers and possibly a few Latin-American contractors or reliable business houses that have been responsible for some of the more successful engineering projects completed in Central and South America.

From several years residence in South America and intimate contact with their engineers, I know how sensitive the Latin-American temperament is. They, quite naturally, resent the attitude of superiority which, unfortunately, is so often taken by individuals and firms in the United States. They have the feeling that "we need each other"—that they have much to learn from us and also that we can—if we will—learn much from them.

I believe that, if the proposed syndicate is properly organized and the proper methods adopted for acquainting prospective clients with its character, ability, and aims, much good and some business will result.

KIRBY SMITH, M. Am. Soc. C.E.

Washington, D.C.
November 24, 1931

Altruism to Win Latin America

DEAR SIR: Dr. Waddell's suggested Latin-American enterprise, as described in his letter in the November number of CIVIL ENGINEERING, is a compliment, as well as a challenge, to the profession.

Subjugation of personal interest to the needs of the client, the professional watchword of truly successful engineering service, must be applied literally and unstintingly if the venture is to succeed. Engineers, as a class, can and do admit the altruistic motive, which may possibly be misunderstood by our Latin-American neighbors. Scepticism will break down, however, as confidence is established through personal contacts.

By reputation, the American approach in Latin America is one of extreme arrogance, or is clothed in the "big brother" attitude. My impression, gained through personal experience, is that it should be as man to man, modest in regard to professional accomplishments, and should emphasize only the fact that our opportunities have permitted a wider experience than theirs.

MERRILL BERNARD, M. Am. Soc. C.E.
Consulting Engineer

Crowley, La.
December 7, 1931

Proposed Engineering Syndicate of Small Value to Latin America

DEAR SIR: I should like to make some comments upon Dr. Waddell's letter, "A Latin-American Engineering and Construction Enterprise," in the November issue of CIVIL ENGINEERING.

Engineering work of a governmental nature in Latin America is usually done by local or "native" engineers, who have been educated in government-subsidized universities, or in the States, or abroad. Some of them have served their apprenticeship with American companies, either in this country or in their own. They have formed engineering societies, such as the Sociedad Columbiana de Ingenieros, Associacion de Ingerieros y Arquitectos de Mexico, Sociedad Cubane de Ingenieros, and the Sociedad de Ingenieros del Peru. Also some of them are members of the American Society of Civil Engineers.

It is only natural that they would be employed on government-financed projects. They take great pride in their engineering accomplishments, descriptions of which are published in the *Revista* of their engineering society. Sometimes the government calls upon an American engineer for advice and review of its plans in collaboration with its own engineers.

Then there is the situation in which the government employs an American construction company to prepare plans and to execute them. Invariably the work is done by American engineers and the plans are approved by the government engineers. When projects are carried out by American companies for their own benefit, American engineers are found within the organizations. However, their plans may have to be approved by the engineers of the Latin-American government.

One finds American construction companies located in the principal cities of Latin America. Their competitors are the native contractors who are technically trained. Then there are the American-owned utilities, industries, and mining companies in these countries which employ American engineers. All of this indicates that American methods and engineering standards are being introduced into those countries which lie to the south of the United States.

As long as sugar is selling below the cost of production and it is not profitable to export hides, or coffee, or to operate mines economically, one cannot expect Latin Americans to show great enthusiasm toward a plan that will increase their expenses directly or indirectly. This is especially true if it is a plan advanced by representatives of a country that has erected high tariff walls, virtually shutting out the products of these countries.

There is missionary work needed in many communities in our own country. Consider the number of towns and cities that do not have a sanitary method of sewage disposal, rubbish collection, garbage disposal, smoke regulation, mosquito control, and the softening of hard waters. Here is an opportunity for a "systematic and scientific effort to develop" America. Why not send lecturers to appear before civic bodies throughout the

United States to explain the needs of the modern community, then approach financial interests with the hope of obtaining the necessary backing to carry out some of the projects?

Viewing the proposed syndicate through the eyes of a Latin American, one sees only financial remuneration to the promoters and only another scheme to take money out of Latin America and put it into the pockets of foreigners. Latin Americans have been used to trickery for so many years that they cannot always comprehend the ethical side of a proposition.

JOHN F. PIERCE, Assoc. M. Am. Soc. C.E.

South Weymouth, Mass.
November 27, 1931

New Latin-American Projects Difficult

DEAR SIR: One does not relish speaking disparagingly of any project or plan which so eminent and distinguished an engineer as J. A. L. Waddell presents. However, I cannot escape the conviction that any "Latin American Engineering and Construction Enterprise" such as is proposed by Dr. Waddell in the November issue would fill no useful object at this time. The "potential resources and business possibilities" existing in Latin America have been greatly exaggerated for many, many years. "Profitable business enterprises" exist only in isolated cases except with state subvention. As is well known, the percentage of failures of private enterprises in Latin America has been unusually large.

No such organization as Dr. Waddell proposes could successfully function without being in a position to finance the projects in which it was interested. In fact, the organization of such a company would attract no attention or interest whatsoever in Central or South America, regardless of the high repute of the men behind it, unless it had substantial capital available for long-term investment in those countries.

In my opinion it will be quite some time before there will be any important amount of American capital available for a long-term investment in Spanish America. There are today well over one billion dollars of South American government bonds in default in this country. In addition, the security market indicates that a huge investment in Cuba and the West Indies of well over one billion dollars is worth from 10 to 50 cents on the dollar. First mortgage bonds of American owned and operated railway properties in Central America and Cuba are selling at from 25 to 50 cents on the dollar.

The most important future construction work to be carried out in Latin America during this generation is probably that of modern highways. This is a luxury, however, which not all countries can afford, and the policy of borrowing in foreign markets for highway construction is one of questionable soundness. Highways should, in general, be paid for by taxation, and only in rare cases can American engineers or contractors fit into this picture.

The return on foreign capital invested in Latin-American enterprises has not, in the main, been sufficiently attractive to induce further heavy investment except in isolated cases. No further railroad building, for example, is economically justifiable in any of the Central American republics, the West Indies, Bolivia, Venezuela, or Ecuador. The public utility field has been well covered and exploited. A great deal of modern sanitation and water supply is, however, yet to be done and no doubt will be done in the next twenty years. This is a work to which American engineers can make a certain contribution.

The difficulties of Dr. Waddell's proposal are twofold—first, that of finding construction enterprises economically warranted; and second, financing them even though the first part of the formula is fully met.

R. W. HEBARD, M. Am. Soc. C.E.
President, R. W. Hebard and Co., Inc.

New York, N.Y.
November 30, 1931

Factors in Trickling Filter Efficiency

TO THE EDITOR: The article by Messrs. Childs and Schroepfer in the December issue presents some interesting data. The sewage treatment plant operator might adversely criticize the use of B.O.D. (bio-chemical oxygen demand) results of a single day together with those representing yearly averages. Yearly average figures, or those covering a considerable period of time, are of greater value in reaching a definite conclusion as to filter efficiency.

An illustration from the Worcester records shows that during a month when the average B.O.D. of the trickling filter effluent was 17.0 p.p.m. (parts per million), it was possible to select twelve consecutive days with an average result of 12.3 p.p.m.; six consecutive days with 17.3 p.p.m.; another six consecutive days with 22.1 p.p.m.; and three consecutive days with 27.5 p.p.m. The figures for the filter influent were 122.4, 149.5, 154.2, and 146.1 p.p.m., respectively; and the percentage reductions were 90.0, 88.5, 85.7, and 81.2, respectively.

Worcester records indicate that atmospheric temperature, as well as strength and rate of application of filter influent, is an important factor when considering trickling filter operation. It is a well known fact that trickling filters located in the colder climates do not function as efficiently in winter as in summer. If the engineer is going to combat cold winter temperatures, consideration must be given to representative B.O.D. figures in estimating the trickling filter load of settled sewage. If the Worcester plant were located in New Jersey or southern Pennsylvania, all other conditions being the same, it is believed that the milder winter temperature conditions would result in material improvement of the quality of the trickling filter effluent during that season of the year. The B.O.D. of the effluent would be decreased as compared with the present figures.

Attention is also directed to the greatly reduced trickling filter efficiency during spring unloading, if consideration is given only to percentage reduction of the B.O.D. of the influent. The latter result may be about normal while that of the effluent is greatly increased. An efficient trickling filter produces such a result. Worcester data indicate a decrease in percentage reduction to below 70 per cent, irrespective of the filter loading.

The present industrial depression has resulted in a decreased B.O.D. of the sewage and the Imhoff tank effluent. With the exception of three winter months, when it was from 3 to 6 per cent greater than usual, the percentage reduction of B.O.D. of the filter influent has remained approximately the same as during corresponding months of the previous year.

ROY S. LANPHEAR
Supervising Chemist, Sewer Department

Worcester, Mass.
December 6, 1931

SEVENTY-NINTH ANNUAL MEETING

An Interesting Program of Sessions, Entertainments, and Trips
New York—January 20–23, 1932

General Session—Prize Awards and Committee Reports

WEDNESDAY—January 20, 1932—Morning—Auditorium

9:00 **Registration**

10:00 **Seventy-Ninth Annual Meeting** called to order by **Francis Lee Stuart,** *President, American Society of Civil Engineers; Consulting Engineer,* New York, N.Y.

10:10 Report of the Board of Direction.
Report of the Secretary.
Report of the Treasurer.

10:35 **CONFERRING OF HONORARY MEMBERSHIP.**

George W. Kittredge, *M. Am. Soc. C.E., Consulting Engineer,* Yonkers, N.Y. Mr. Kittredge will be presented to the President by J. VIPOND DAVIES, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

Daniel W. Mead, *M. Am. Soc. C.E.,* Professor of Hydraulic and Sanitary Engineering, University of Wisconsin; *Consulting Engineer,* Madison, Wis. Professor Mead will be presented to the President by G. GALE DIXON, *M. Am. Soc. C.E., Deputy Chief Engineer,* Mahoning Valley Sanitary District, Youngstown, Ohio.

George H. Pegram, *Past-President Am. Soc. C.E., Chief Engineer, Interborough Rapid Transit Company and Rapid Transit Subway Construction Company,* New York, N.Y. Mr. Pegram will be presented to the President by ARTHUR S. TUTTLE, *M. Am. Soc. C.E., Consulting Engineer, Board of Estimate and Apportionment,* New York, N.Y.

Palmer C. Ricketts, *M. Am. Soc. C.E., President of, and Professor of Mechanics, Rensselaer Polytechnic Institute,* Troy, N.Y. Professor Ricketts will be presented to the President by GEORGE S. DAVISON, *Past-President, Am. Soc. C.E., President, Davison Coke and Iron Company,* Pittsburgh, Pa.

Members of the Society in the Metropolitan District are to be hosts to those who travel to New York to attend the Seventy-Ninth Annual Meeting, January 20–23. Careful plans have been laid to provide for the material comfort and intellectual interests of all members and guests in attendance. From the time the outgoing Board of Direction completes its 1931 business, on Tuesday, January 19, until the last inspection trip on Saturday, there is planned a continuous sequence of events, that will keep all in attendance comfortably busy.

11:00 **PRESENTATION OF MEDALS AND PRIZES.**

NORMAN MEDAL

To **Floyd A. Nagler,** *M. Am. Soc. C.E., Professor of Hydraulic Engineering, University of Iowa,* Iowa City, Iowa, and ALBION DAVIS, *M. Am. Soc. C.E., Chief Engineer, Mississippi River Power Company,* Keokuk, Iowa, for Paper No. 1744, "Experiments on Discharge over Spillways and Models, Keokuk Dam." Messrs. Nagler and Davis will be presented to the President by DANA M. WOOD, *M. Am. Soc. C.E., Assistant to Chief Hydraulic Engineer, Stone and Webster Engineering Corporation,* Boston, Mass.

J. JAMES R. CROES MEDAL

To **John R. Freeman,** *Past-President and Honorary Member Am. Soc. C.E., Consulting Hydraulic Engineer; President, Manufacturers Mutual Fire Insurance Company,* Providence, R.I., for Paper No. 1726, "Flood Control on the River Po in Italy." Mr. Freeman will be presented to the President by JOHN F. STEVENS, *Past-President and Honorary Member, Am. Soc. C.E.,* Baltimore, Md.

THOMAS FITCH ROWLAND PRIZE
RUDOLPH HERING MEDAL *of the Sanitary Engineering Division*

Both to **Samuel A. Greeley,** *M. Am. Soc. C.E., Consulting Engineer,* Chicago, Ill., and **William D. Hatfield,** *Assoc. M. Am. Soc. C.E., Superintendent, Sewage Disposal Plant,* Decatur, Ill., for Paper No. 1738, "The Sewage Disposal Works of Decatur, Illinois." Messrs. Greeley and Hatfield will be presented to the President by JOHN H. GREGORY, *M. Am. Soc. C.E., Consulting Engineer, Professor of Civil and Sanitary Engineering, The Johns Hopkins University,* Homewood, Baltimore, Md.

ARTHUR M. WELLINGTON PRIZE

To **George F. Schlesinger,** *M. Am. Soc. C.E., Chief Engineer and Managing Director, National Paving Brick Manufacturers Association,* Washington, D.C., for Paper No. 1736, "The Practical Utility of Highway Transport Surveys." Mr. Schlesinger will be presented to the President by ROY W. CRUM, *M. Am. Soc. C.E., Director, Highway Research Board, National Research Council,* Washington, D.C.

11:30 **PRESENTATION OF REPORTS OF COMMITTEES.**

Committee on Earths and Foundations.
LAZARUS WHITE, *M. Am. Soc. C.E., President, Spencer, White and Prentis, Incorporated,* New York, N.Y., *Chairman.*

Committee on Irrigation Hydraulics.
D. C. HENNY, *M. Am. Soc. C.E., Consulting Engineer,* Portland, Ore., *Chairman.*

Committee on Salaries.
E. P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y., *Chairman.*

12:15 **NEW BUSINESS.**

Report of Tellers on Canvass of Ballot for Officers.

Introduction of President-Elect.

12:45 **LUNCHEON.**

Fifth Floor, Engineering Societies Building. Tickets, $1.00 each.

Use Railroad Certificate to Obtain Reduced Fare. Consult Your Ticket Agent for Selling Date in Your Territory

Engineering Economics, President's Reception, and Dance

WEDNESDAY—January 20, 1932—Afternoon—Auditorium

Engineering–Economics and Finance Division

2:15 "THE VERTICAL CLEARANCE REQUIRED AT BRIDGES BELOW SEAPORTS"

C. E. GRUNSKY, *Past-President, Am. Soc. C.E., Consulting Engineer,* San Francisco, Calif.

2:40 "LEGAL PHASES OF THE SUBJECT BRIDGE CLEARANCES"

WALTER H. WHEELER, *M. Am. Soc. C.E., Designing and Consulting Engineer,* Minneapolis, Minn.

3:05 General Discussion.

3:25 "PRESENT STATUS OF VALUATION PROCEDURE."

E. B. BLACK, *M. Am. Soc. C.E., Consulting Engineer,* Kansas City, Mo.

3:50 Discussion Opened by

ANSON MARSTON, *Past-President Am. Soc. C.E., Dean of Engineering, Iowa State College,* Ames, Iowa; *Chairman, Division Committee on Valuation Procedure and Depreciation.*

4:10 General Discussion.

4:30 "LONG RANGE PLANNING OF CONSTRUCTION."

D. H. SAWYER, *M. Am. Soc. C.E., Director, Federal Employment Stabilization Board,* Washington, D.C.

PLEASE REGISTER

All who attend the Annual Meeting are requested to register immediately upon their arrival at Engineering Societies Building. Registration will be on the main floor. Badges and tickets for all functions should be obtained at the time of registration.

WEDNESDAY—January 20, 1932—Evening—Roosevelt Hotel

The President's and Honorary Members' Dinner, Reception, and Dance

DINNER AND DANCE COMMITTEE: WILLIAM J. SHEA, CHAIRMAN, DEAN G. EDWARDS, EDWARD ANDERBERG

7:00 Assembly.

7:30 Dinner.

9:30 Reception to the President and Honorary Members.

10:00 Dancing.

This Function will be held at the Hotel Roosevelt, Madison Avenue and Forty-Fifth Street, the Grand Ball Room to open at 7:00 P.M. and the Dinner to be served promptly at 7:30 P.M.

Arrangements have been made for tables seating ten persons, and members may underwrite complete tables. *Orders to underwrite a table must be accompanied by check in full, and a list of guests.*

The Seating List will close at 5:00 P.M., Tuesday, January 19, 1932. Those who purchase tickets after 5:00 P.M., January 19, will be assigned to tables in the order of their purchase.

Tickets will be on sale at Society Headquarters until 5:00 P.M., Wednesday, January 20, 1932.

Tickets will be $5.00 each.

THURSDAY'S TECHNICAL DIVISION MEETINGS ARE DETAILED ON PAGES 52 AND 53

Entertainment for Ladies—Smoker for Men

THURSDAY—January 21, 1932—Afternoon and Evening

LADIES COMMITTEE: MRS. W. L. HANAVAN, CHAIRMAN, MRS. CHARLES E. TROUT, MRS. FREDERICK C. NOBLE AND MRS. WILLIAM McK. GRIFFIN, VICE-CHAIRMAN.

2:30 INSPECTION OF THE NEW HOTEL WALDORF-ASTORIA, 50TH STREET AND PARK AVE.

Through the courtesy of the Management of the Waldorf-Astoria, Visiting Ladies will have the opportunity of inspecting the facilities of this most modern hostelry.

For the Inspection Trip, the Ladies will assemble in Peacock Alley, 2:30 to 3:00 P.M.

3:30 TEA.

Following the Inspection Trip, Tea will be served in the Sert Room of the Waldorf-Astoria.

There will be no charge for Visiting Ladies.

There will be no charge for One Ticket to Ladies of members resident in District No. 1. Additional Tickets may be obtained at $1.00 each.

8:00 SOCIAL EVENING AND ENTERTAINMENT.

The Ladies will be entertained at the Engineering Woman's Club. All Ladies are invited to attend.

The Ladies Committee, will be the Hostesses.

ENGINEERING WOMAN'S CLUB HOST TO VISITING LADIES

Through the courtesy of the Engineering Woman's Club, Inc., 123 East 37th Street, the facilities of that Club will be available to the Ladies during the entire Annual Meeting. All Ladies are especially invited to make the Club their Headquarters. Members of the Ladies' Committee will be at the Club to assist Visiting Ladies in getting acquainted, to furnish information about shopping, sight-seeing, or other points of interest. There will be an Information Desk for Ladies at Society Headquarters, and all Ladies are requested to avail themselves of the facilities of the Society or the Engineering Woman's Club.

THURSDAY—January 21, 1932—Evening—Auditorium

Entertainment and Smoker

COMMITTEE: E. M. VAN NORDEN, CHAIRMAN, ALBERT B. HAGER AND BILLINGS WILSON.

8:00 MAGIC—SCIENTIFIC AND REAL.

There is something about magic that holds everybody's interest. All have been amazed by the skill and science in the modern practice of the magic art. Probably few have thought of the sharp distinction between scientific magic and real magic. Space does not permit a suitable and complete explanation of the differences. Therefore, this is merely notification that a fascinating evening is in store.

At the close of the demonstration, there will be a Smoker on the Fifth Floor.

For those who may not care to smoke or who may wish to smoke or visit quietly with friends, a continuous entertainment, consisting of interesting motion picture films interspersed with music, will be provided in the Auditorium.

Tickets for the Smoker and Evening's Entertainment are free to Members; Guest tickets, $2.00 each.

College Reunions Throughout the Week

Sanitary Engineering Division Dinner and Eleventh Alumni Gatherings Scheduled for Visiting Engineers

January 19th to 23rd

TUESDAY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY DINNER-DANCE

The Technology Club of New York invites all M.I.T. alumni and their ladies to its Annual Dinner-Dance at the new Waldorf-Astoria Hotel on Tuesday evening, January 19, 1932.

A feature of the evening's entertainment will be the new 1,500,000-volt atom-smashing machine which will be demonstrated by Prof. de Graaf, its inventor. President Compton, Dean Lobdell, Bursar Ford, and Registrar MacKinnon will be guests at the dinner.

The charge per cover will be $5.00. Further information may be obtained and reservations made through Milton Male, Technology Club, 22 East 38th Street, New York, N.Y., telephone Calcedonia 5-1475.

THURSDAY

BROWN ENGINEERING ASSOCIATION

The Brown Engineering Association will hold an informal luncheon at the Brown Club, Hotel Wentworth, 59 West 46th Street, New York, N.Y., on Thursday, January 21, 1932, from 12:30 to 2:00 P.M., to which all Brown Engineering Alumni are invited.

DINNER OF COLUMBIA ENGINEERS

The graduates of Columbia University who are members of the American Society of Civil Engineers will meet for an Informal Dinner on Thursday, January 21, 1932, at 6:15 P.M., at the Columbia University Club, 4 West 43d Street, New York, N.Y. The charge will be $2.25 per cover. Address communications to Professor James K. Finch, Columbia University, New York, N.Y.

UNIVERSITY OF ILLINOIS ENGINEERS DINNER

All University of Illinois Engineers are invited to the Fourth Annual Informal Dinner-Reunion at Ware Tea Room, 52 West 39th Street, New York, N.Y., on Thursday, January 21, 1932, at 5:45 P.M.

The Dinner will precede the Society's Smoker. If you plan to attend, please notify H. E. Wessman, Care, Waddell and Hardesty, 150 Broadway, New York, N.Y.

UNIVERSITY OF PENNSYLVANIA CIVIL ENGINEERS DINNER

The Thirteenth Annual Informal Dinner of the University of Pennsylvania Civil Engineers will be held at the Pennsylvania Club, 35 East 50th Street, New York, N.Y., on Thursday, January 21, 1932, from 6:00 to 7:30 P.M. The Dinner fills in the time from the end of the Technical Session at 5:00 P.M., until the commencement of the Smoker at 8:00 P.M. Dinner will be served at 6:00 P.M. sharp.

The charge per cover will be $2.00. Any further information can be obtained from William G. Grove, Care, Robinson and Steinman, Room 1104, 117 Liberty Street, New York, N.Y.

ANNUAL DINNER OF SANITARY ENGINEERING DIVISION

The Annual Dinner of the Sanitary Engineering Division, American Society of Civil Engineers, will be held on Tuesday, January 19, 1932 at 7:30 P.M., at the Hotel McAlpin, Broadway and 34th Street, New York, N.Y. Commissioner Leonard C. L. Smith, Engineer Member of the Sanitary Commission of New York City, will give a talk on the operations of the Department of Sanitation. The charge per cover will be $4.00. Reservations should be made not later than January 15, 1932, through Richard H. Gould, Room 1201, Municipal Building, New York, N.Y.

FRIDAY

CORNELL UNIVERSITY ENGINEERS' ALUMNI DINNER

There will be an informal dinner meeting for visiting Cornell Engineers and local members of the Cornell Society of Engineers on Friday, January 22, 1932, at 6:30 P.M., at the Cornell Club of New York, 245 Madison Avenue, New York, N.Y. Please notify E. C. M. Stahl, 380 Pearl Street, Brooklyn, N.Y., of your intention to be present.

HARVARD-YALE-PRINCETON SMOKER

The 1932 Joint Meeting of the Harvard Engineering Society and the Yale and Princeton Engineering Associations will be held on Friday evening, January 22, 1932. The Harvard Engineering Society will be host for the evening. The meeting will be held at the Harvard Club, 27 West 44th Street, and an interesting program has been arranged for the evening. Members of these Societies in the Metropolitan District and from out of town are invited to be present and they are assured of a very enjoyable time.

SYRACUSE UNIVERSITY ALUMNI DINNER

Graduates and former students of the College of Applied Science, Syracuse University, will hold a dinner at Keen's Chop House on 36th Street near 6th Avenue, New York, N.Y., at 6:30 P.M., Friday, January 22, 1932. Reservations at $2.25 per plate may be secured by writing Mr. Stan F. Yasines, Instructor in Civil Engineering, New York University, University Heights, New York, N.Y.

THAYER SOCIETY OF ENGINEERS OF DARTMOUTH COLLEGE

The Annual Meeting and Dinner of the Thayer Society of Engineers of Dartmouth College will be held at the Dartmouth College Club, New York, N.Y., at 6:30 P.M., Friday, January 22, 1932. The charge per cover will be $2.75. Notify the Dartmouth College Club, 24 East 38th Street, New York, N.Y., as to attendance.

UNION COLLEGE ENGINEERS DINNER

The Eighth Annual Informal Dinner of the Union College Engineers Club will be held at the Engineers Club, 32 West 40th Street, New York, N.Y., at 6:30 P.M., Friday, January 22, 1932. Reservations may be made through H. Garnett Davis, Care, Francisco and Jacobus, 511 Fifth Avenue, New York, N.Y.

SATURDAY

CLARKSON COLLEGE ALUMNI DINNER MEETING

The Annual Dinner and Business Meeting of the Clarkson College Alumni Association will be held at the Hotel McAlpin, New York, N.Y., on Saturday, January 23, 1932. The Business Meeting will be held in Room E at 2:00 P.M., to which all Alumni members are invited. The Dinner will be held in the Blue Room at 6:30 P.M. The charge per cover will be $4.00. Notify Frank C. Boes, 38 Cypress Street, Floral Park, N.Y., as to attendance.

Sessions of Technical Divisions Occupy Full Day

THURSDAY—January 21, 1932—Morning

Highway Division

10:00 **"NEW JERSEY APPROACHES TO THE GEORGE WASHINGTON BRIDGE."**

J. L. BAUER, *M. Am. Soc. C.E., State Highway Engineer, New Jersey State Highway Commission*, Trenton, N.J.

"UNEMPLOYMENT RELIEF ACTIVITIES IN TWIN CITIES."

WILLIAM N. CAREY, *M. Am. Soc. C.E., Chief Engineer, Department of Public Works*, St. Paul, Minn.

GEORGE WASHINGTON BRIDGE
Traffic Looking East from Traffic Booths

Sanitary Engineering Division

10:00 **REPORT OF COMMITTEE ON PROGRESS AND STATUS OF THE ART OF SANITARY ENGINEERING.**

LANGDON PEARSE, *M. Am. Soc. C.E., Sanitary Engineer Sanitary District of Chicago*, Chicago, Ill., *Chairman.*

"THE ACTIVATED SLUDGE PROCESS OF SEWAGE TREATMENT."

JAMES R. MCCLINTOCK, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

REPORT OF COMMITTEE ON SLUDGE DIGESTION.

SAMUEL A. GREELEY, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill., *Chairman.*

Construction Division—Structural Division

Joint Session

10:00 **REPORT OF SUB-COMMITTEE ON "WIND BRACING ON TALL BUILDINGS."**

C. R. YOUNG, *M. Am. Soc. C.E., Professor of Civil Engineering, University of Toronto*, Toronto 5, Ont., Canada, *Chairman.*

10:30 **Discussion by**

H. L. DRYDEN, Esq., *Chief, Aerodynamical Physics Section, U.S. Bureau of Standards*, Washington, D.C.

S. C. Hollister, *Assoc. M. Am. Soc. C.E.*, Professor of *Structural Engineering, and Assistant Director, Materials Testing Laboratory, Purdue University*, Lafayette, Ind.

11:15 **"BUILDING FOUNDATIONS."**

C. S. PROCTOR, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

12:00 **Discussion by**

H. J. DEUTSCHBEIN, *Assoc. M. Am. Soc. C.E., President H. J. Deutschbein Company, Inc.*, New York, N.Y.

THOMAS CRIMMINS, Esq., *President, Thomas Crimmins Contracting Company*, New York, N.Y.

RALPH H CHAMBERS, *M. Am. Soc. C.E., Vice-President, The Foundation Company*, New York, N.Y.

NEW YORK'S MID-TOWN SKY LINE
From the East River

THURSDAY—January 21, 1932—Afternoon

Construction Division—Structural Division

Joint Session

2:30 **"SUBWAY FOUNDATIONS."**

LAZARUS WHITE, *M. Am. Soc. C.E., President, Spencer, White and Prentis, Inc.*, New York, N.Y.

3:15 **Discussion by**

CHARLES H. STEVENS, *M. Am. Soc. C.E., Chief Engineer, Department of City Transit*, Philadelphia, Pa.

HERBERT M. HALE, *M. Am. Soc. C.E., Chief Engineer, Marcus Contracting Company*, New York, N.Y.

JOHN R. SLATTERY, *M. Am. Soc. C.E., Deputy Chief Engineer, Board of Transportation*, New York, N.Y.

4:00 **"BRIDGE FOUNDATIONS."**

J. J. YATES, *M. Am. Soc. C.E., Bridge Engineer, Central Railroad of New Jersey*, Jersey City, N.J.

4:45 **Discussion by**

T. L. CONDRON, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

J. WRIGHT TAUSSIG, *Assoc. M. Am. Soc. C.E., Vice-President, Raymond Concrete Pile Company*, New York, N.Y.

N. F. HELMERS, Esq., *Seims, Helmers, Inc.*, St. Paul, Minn.

Power Division

2:30 **"FEDERAL POWER COMMISSION'S FIELD OF WORK."**

DR. GEORGE OTIS SMITH, *Chairman, Federal Power Commission*, Washington, D.C.

3:15 **Discussion.**

4:00 **General Discussion of Power Division Activities.**

Surveying and Mapping Division

2:30 **"GEODETIC CONTROL FOR NORTH CAROLINA HIGHWAYS, ITS ADVANTAGES, AND ITS PROBABLE EFFECT ON ENGINEERING PRACTICE IN THE STATE."**

GEORGE F. SYME, *M. Am. Soc. C.E., Senior Highway Engineer, State Highway Commission, Raleigh, N.C.*

Discussion by

HENRY J SHERMAN, *M. Am. Soc. C.E., Consulting Engineer, Board of Commerce and Navigation of New Jersey; Consulting Engineer*, Camden, N.J.

"THE PLACE OF SURVEYING IN ENGINEERING EDUCATION."

JAMES K. FINCH, *M. Am. Soc. C.E., Renwick Professor, and Director, Summer School of Surveying, Columbia University*, New York, N.Y.

City Planning Division

2:30 **"LOCATION OF UNDERGROUND UTILITIES."**

ARTHUR W. CONSOER, *M. Am. Soc. C.E., Vice-President and General Manager, Consoer, Older and Quinlan, Inc.*, Chicago, Ill.

"STREET NAMES AND NUMBERS."

J. P. SCHWADA, *Assoc. M. Am. C.E., City Engineer*, Milwaukee, Wis.

Discussion by

BANCROFT GHERARDI, Esq., *Vice-President, American Telephone and Telegraph Company*, New York, N.Y.

W. W. HORNER, *M. Am. Soc. C.E., Chief Engineer, Sewers and Paving*, St. Louis, Mo.

MAURICE SERATING, Esq., *Mechanical Designer, Board of Transportation*, New York, N.Y.

Discussion opened by

C. U. POWELL, *M. Am. Soc. C.E., Engr. in chg., Typographical Bureau*, Borough of Queens, Flushing, N.Y.

VIADUCT CONSTRUCTION BETWEEN JERSEY CITY AND NEWARK
Connecting Link for Route 25, New Jersey Highway Commission

Inspection Trip to Notable Bridges

Recently Constructed in New York and New Jersey

FRIDAY—January 22, 1932—All Day

10:00 EXCURSION TO POINTS OF ENGINEERING INTEREST IN NEW YORK AND NEW JERSEY, INCLUDING:

George Washington Bridge over the Hudson River.

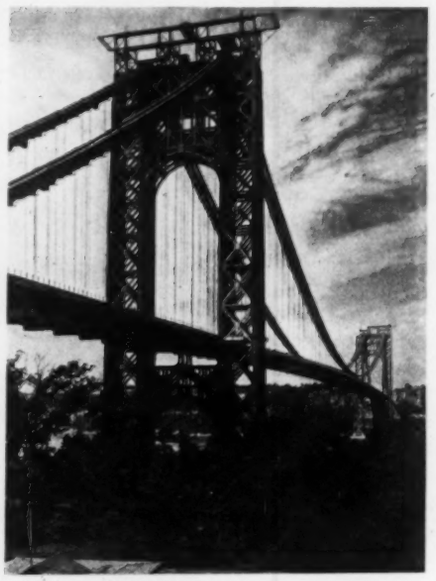
Goethals Bridge between Elizabeth, N.J., and Staten Island.

Bayonne Bridge between Bayonne, N.J., and Staten Island.

New Jersey State Highway Improvements, Park Developments, etc.

EXCURSION COMMITTEE: J. J. YATES, CHAIRMAN, MONTGOMERY B. CASE AND ENOCH R. NEEDLES.

The party will leave Engineering Societies Building, 33 West 39th Street, promptly at 10:00 A.M., in buses, going via Riverside Drive to the George Washington Bridge. Here there will be opportunity to see the Bridge advantageously as well as the approaches to the structure in New York and New Jersey. After the inspection, the party will proceed to the Plaza Hotel, Jersey City, New Jersey, for Luncheon, as guests of the American Bridge Company, The McClintic-Marshall Company, and the John A. Roebling's Sons Company.



GEORGE WASHINGTON BRIDGE

Governor-Elect A. Harry Moore, of the State of New Jersey has been invited to address the meeting following Luncheon.

The Excursion to Jersey City will follow a route along the Palisades from which there is an exceptional and striking view of the New York City skyline. Following Luncheon, the group will again board the buses proceeding southward to and over the Goethals Bridge to Staten Island. Points of engineering interest will include the New Jersey Elevated Highway Development, Park Improvements, Newark Airport, etc. Part of the route will be over New Jersey State Highway No. 25, the Express Highway connecting New York City and Philadelphia.

After viewing the Goethals Bridge, the Excursion will proceed from Staten Island back to New Jersey over the Bayonne Arch Bridge over the Kill van Kull, thence northward to Journal Square, Jersey City, returning to New York City via the Holland Tunnel and the West Side Elevated Highway. A stop will be made at Journal Square, about 4:00 P.M., for those who wish to leave the Excursion at this point. The Excursion will terminate at the Pennsylvania Station in New York about 4:30 P.M. Tickets for the Excursion, including Luncheon, are $1.50 each.

BAYONNE BRIDGE OVER KILL VAN KULL

ERECTING RIVER CROSSING, NEW JERSEY ROUTE 25

Wide Variety of Excursions Provided

SATURDAY—January 23, 1932—Morning

INSPECTION TRIPS.

Arrangements have been made for visits to the following points of engineering interest. As these trips all start about the same hour, it will not be possible to participate in more than one.

(1) Tri-Borough Bridge, connecting the Boroughs of Manhattan, the Bronx and Queens.

(2) Bridge, Boulevard, and other Developments under Westchester County Parkway Commission.

(3) U.S. Navy Yard, Brooklyn, N.Y.

(4) Westchester County Sanitary Improvements.

TRI-BOROUGH BRIDGE

This Bridge will connect Manhattan, Bronx, and Queens, and will require four years for completion. The Main Bridge from the Bronx to Queens is 13,560 ft. long, and the Manhattan Connection from the Main Bridge to East 125th Street is 4,150 ft. long. The following is descriptive of the type of structure:

Hell Gate Crossing—Suspension Span 1,380 ft.

Little Hell Gate Crossing—Two Steel Arches, each 375 ft.

Bronx Kills Crossing—Two Spans, each 125 ft.

Harlem River Crossing, Vertical Lift Span, 320 ft.

The Approach Spans in Manhattan, Bronx, and Queens and on Wards Island and Randalls Island, will consist of granite-faced masonry arches and viaducts and steel arches and viaducts. Eight lanes of traffic will be accommodated on the Main Bridge and six lanes on the Manhattan Connection. By means of a masonry structure at the intersection of the Manhattan Connection with the Main Bridge, consisting of ramps and loops, uninterrupted traffic will be maintained to and from all three Boroughs, in all directions.

Buses will leave Society Headquarters, 33 West 39th Street, at 10:00 A.M., and proceed to the Queens Anchorage in Astoria and the Queens Tower Pier. After this inspection, the group will be transferred across Hell Gate for a view of the work on the Wards Island Tower, Anchorage and Pier Foundations.

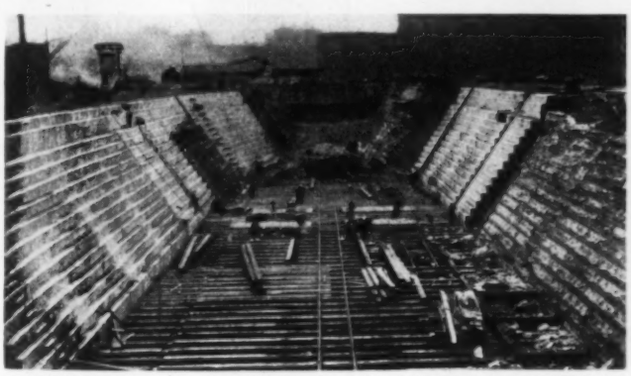
The party will then proceed on the S.S. "Macom" up the Harlem River, landing at the foot of East 125th Street, Manhattan, where the vertical lift bridge is to be built over the Harlem River.

WESTCHESTER COUNTY PARKWAY DEVELOPMENTS

The members visiting the work of the Westchester County Park Commission will take the 9:03 A.M. train from Grand Central Terminal to Bronxville, arriving at 9:33 A.M. Here they will be met by engineers of the Commission and go, by automobile, over the Bronx River Parkway, with side trip to see the Kensico Dam and aeration fountains. The group will then go over the Bronx Parkway extension to Croton Lake to see the 750-ft. three-hinged arch span over Croton Lake.

PARKWAY IN WESTCHESTER COUNTY

The Playland Park and the Hutchinson River Parkway Development will be seen on the return, the group returning to New York via train.



DRY DOCK REPAIRS—BROOKLYN NAVY YARD

U.S. NAVY YARD, BROOKLYN, N.Y.

The following are some points of interest at the Navy Yard:

Reconstruction work on a dry dock in which defective concrete facing of side walls is being replaced by a reenforced concrete altar slab tied back into relieving platform about 4 ft. below the surface at back of wall, with reaction at bottom being taken by timber struts in the floor of the dock; temporary steel sheet pile cofferdam to keep out the sea; concrete sea walls with deteriorated face being reconstructed by splitting a granite coping and using slabs as a facing for the concrete wall from timber supporting platform up; concrete piers on timber foundations have been repaired by replacing defective concrete by cement gun process; shops where the structural material for shipbuilding is fabricated; Machine Shops where engines of various types are built; boiler shops; foundry; central power plant where electric current, compressed air and hydraulic power are produced; Testing Laboratory.

Respecting ships so far as can be predicted there will probably be one of the 10,000 ton cruisers with 8 in. guns; destroyers; the 10,000 ton, 8 in. gun cruiser U.S.S. New Orleans under construction.

The Navy Yard may be reached via Graham Avenue or Flushing Avenue street cars taken at the New York end of the Brooklyn Bridge, thence to the Cumberland Street Gate of the Navy Yard. In going to the Navy Yard by automobile, cross the Manhattan Bridge and turn left at Brooklyn end, proceeding to Flushing Avenue to Cumberland Street Gate.

WESTCHESTER COUNTY SANITARY IMPROVEMENTS

Members visiting the sanitary improvement work of the Westchester County Sanitary Commission will take the 9:03 A.M. train from Grand Central Terminal to White Plains, arriving at 9:49 A.M. Here they will be met by engineers of the Commission and go by automobile to visit a number of the sanitary works, including:

(1) Blind Brook Project Pumping Station, in Rye, a compact automatic plant, with perfect concealment, handling sewage from a peak transient population of 200,000. Playland, one of Westchester County's bathing and amusement parks, is located at Rye on Long Island Sound.

(2) Blind Brook Treatment Plant, a compact plant serving a winter population of 10,000 and a summer population of 200,000 with incineration of screenings with garbage. The wide fluction in flow is an exceptional feature of this plant.

STEEL ARCH OVER CROTON LAKE—750 FT. SPAN

(3) Mamaroneck Sewage Screening Plant and Outfall, a plant in the heart of a business district, with discharge of effluent under 60 ft. of salt water by outfall more than 2 miles long. Although this plant is under construction; it is also in operation.

(4) Hutchinson Project Low Level Pumping Station, a 25,000 G.P.M. plant so well housed that it will be taken for a residence.

(5) Trunk sewer construction and possibly leakage test and other features.

(6) Sawmill Project 78-in. sewer tunnel, extending more than two miles under streams, streets, and buildings, through wet soft ground is being constructed under air pressure. Liner plates protect the concrete. Local sewers drop vertically into the trunk line.

(7) Bronx Valley sewer tunnel, more than five miles long, and the South Yonkers Sewage Treatment Plant on the Hudson. This interceptor is one of the longest sewer tunnels built.

Reduced Railroad Fares—Hotel Rates—Tickets

REDUCED RAILROAD RATES

Reduced rates on the Identification Certificate Plan have been granted by the Passenger Associations of the United States and the Lines of the Canadian Passenger Association.

A certificate authorizing purchase, at starting point, of round-trip tickets good for 30 days, on the one and one-half fare basis, has been mailed to the membership of the Society.

Selling dates for tickets in the territory of the Trunk Line, New England, Central, Southeastern, and Canadian (Eastern Lines) Passenger Associations are January 16 to 22.

In the territory of the Southwestern, Western, Transcontinental, and Canadian (Western Lines) Passenger Associations, the opening dates of sale vary from January 6 to 16, and the closing dates from January 12 to 22, depending upon location and travel.

As certificates cannot be used after the closing date of sale, consult your Ticket Agent about selling dates in your territory.

ORDER ALL TICKETS IN ADVANCE

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the Committee greatly in giving advance information to guide it in concluding arrangements. Ticket order blanks have been mailed to each member with the railroad certificate and condensed program.

No cancellation of tickets can be made after noon of Wednesday, January 20, 1932.

HOTEL RATES

	Without Private Bath		With Private Bath	
	Single Room	Double Room	Single Room	Double Room
Roosevelt	.....	.....	$4.50 up	$ 6.00 up
Astor	$2.50 up	$4.50 up	3.00 up	4.50 up
Commodore*	.....	.....	3.50 up	5.00 up
McAlpin	2.50 up	4.50 up	3.50 up	6.00 up
Murray Hill	2.00 up	4.00 up	3.50 up	4.50 up
New Yorker*	.....	.....	3.50 up	5.00 up
Pennsylvania*	.....	.....	4.00 up	6.00 up
Plaza*	.....	.....	6.00 up	8.00 up
Prince George*	.....	.....	2.50 up	4.00 up
Savoy-Plaza*	.....	.....	7.00 up	8.00 up
Taft	2.00 up	3.00 up	2.50 up	3.50 up
Vanderbilt*	.....	.....	3.00 up	6.00 up
Waldorf-Astoria*	.....	.....	7.00 up	10.00 up
Wellington	2.00 up	3.00 up	2.50 up	4.00 up

* All rooms with bath.

NOTE.—The Hotel Roosevelt at which the Reception, Dinner, and Dance will be held, will care for reservations to the extent of its capacity. If unable to furnish accommodations the Roosevelt management has arranged to make the reservations at nearby hotels.

HOTEL ACCOMMODATIONS

In order to be certain of accommodations, members are urged to make definite arrangement for rooms at least a week in advance of the Annual Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in New York.

INFORMATION DESK

An Information Desk is provided in the Reading Room of the Society on the Fifteenth Floor of Engineering Societies Building to assist visiting members in obtaining hotel reservations, theater tickets, and any other information about the city. Your attention is called to the facilities of the Reading Room (open until 9:00 P.M. Tuesday, Wednesday, and Thursday evenings), for meeting friends, writing letters, and receiving mail. All members are welcome to inspect and utilize the quarters of the Society.

INTRODUCTIONS FOR VISITING MEMBERS

Members who wish, during their attendance at the Annual Meeting, introductions or meetings with engineers in New York City, may call on the Secretary's Office for any service desired.

SOCIETY HEADQUARTERS
Engineering Societies Building, New York

COMMITTEE ON LOCAL ARRANGEMENTS FOR THE ANNUAL MEETING

WILLIAM L. HANAVAN, *Chairman*
CHARLES E. TROUT, *Vice-Chairman*
EDWARD ANDERBERG
MONTGOMERY B. CASE
DEAN G. EDWARDS
WILLIAM MCK. GRIFFIN
ALBERT B. HAGER
ENOCH R. NEEDLES
WILLIAM J. SHEA
E. M. VAN NORDEN
BILLINGS WILSON
J. J. YATES

LADIES COMMITTEE

MRS. WILLIAM L. HANAVAN, *Chairman*
MRS. CHARLES E. TROUT, *Vice-Chairman*
MRS. FREDERICK C. NOBLE, *Vice-Chairman*
MRS. WILLIAM MCK. GRIFFIN, *Vice-Chairman*
MRS. O. H. AMMANN
MRS. EDWARD ANDERBERG
MRS. MONTGOMERY B. CASE
MRS. DEAN G. EDWARDS
MRS. ALBERT B. HAGER
MRS. ENOCH R. NEEDLES
MRS. ROBERT RIDGWAY
MRS. GEORGE T. SEABURY
MRS. WILLIAM J. SHEA
MRS. EDWARD W. STEARNS
MRS. E. M. VAN NORDEN
MRS. BILLINGS WILSON
MRS. J. J. YATES
MISS S. H. YATES

Please call on the Committee on Local Arrangements or on the Secretary's Office for any service desired.

SOCIETY AFFAIRS

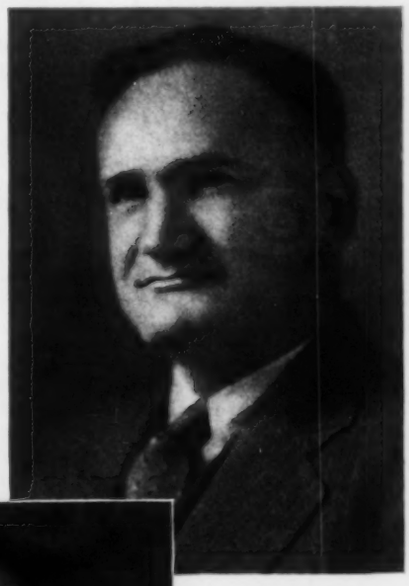
Official and Semi-Official

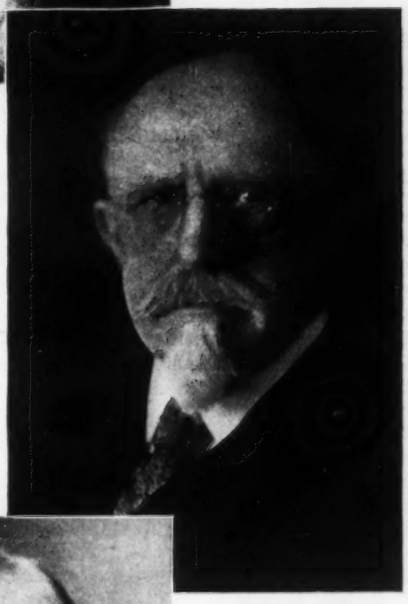
Society Prize Winners 1931

The Norman Medal for Paper No. 1744, "Experiments on Discharge Over Spillways and Models, Keokuk Dam"

ALBION DAVIS

FLOYD A. NAGLER





JOHN R. FREEMAN

The J. James R. Croes Medal for Paper No. 1726, "Flood Control on the River Po in Italy"

GEORGE F. SCHLESINGER

The Arthur M. Wellington Prize for Paper No. 1736, "The Practical Utility of Highway Transport Surveys"

SAMUEL A. GREELEY

WILLIAM D. HATFIELD

The Thomas Fitch Rowland Prize for Paper No. 1738, "The Sewage Disposal Works of Decatur, Ill."

Papers in TRANSACTIONS *Awarded Prizes*

Among the purposes of the Society as stated in its constitution are "the advancement of the sciences of engineering" and the "professional improvement of its members." Thus it is that papers are prepared for presentation at Society Meetings and for printing in its official publications. To encourage the preparation of papers and to constantly raise the standard of their excellence and usefulness to the profession, a number of prizes are offered annually for papers published in TRANSACTIONS. Early in each year the Board of Direction appoints three corporate members who are not members of the Board, to act as a Committee on Prize Awards. All papers printed in TRANSACTIONS during the previous year, ending in July, are critically examined by the committee for compliance with the Code of Rules and its recommendations to the Board of Direction are acted upon by the Board, usually in October.

Announcement of the recipients of the coveted prizes for 1931 was made at the St. Paul meeting of the Board on October 5 and 6. A brief note concerning the winners was published in the November issue of CIVIL ENGINEERING, on page 1292. During the Annual Meeting, the prizes are to be publicly awarded. On the previous page appear photographs of the winners, together with the titles of the papers for which the awards were made.

The Norman Medal is awarded for a paper giving the most meritorious contribution to engineering science by a member of the Society. It consists of a gold medal having a value of $60, the dies for which are entrusted to the Philadelphia Mint. This prize was instituted and endowed in 1872 by the late George H. Norman, M. Am. Soc. C.E., and is the oldest of the Society awards. It is not often that this prize goes to joint authors as is true this year, but both will receive identical gold medals, each medal inscribed with both names. For practical reasons, replicas of the gold medal have been cast in bronze and plated with gold. These, too, will be presented to each of the authors.

In 1912 the Society established the J. James R. Croes Medal, named for the first recipient of the Norman Medal. The rules for the award are the same as for the Norman Medal, except that it is made for the paper judged to be second in excellence as a contribution to engineering science. The medal itself has a value of $40 and a bronze replica is also presented to the winner.

Endowed in 1884 by the late Thomas Fitch Rowland, Hon. M. Am. Soc. C.E., the prize bearing his name is not limited in its award to members of the Society. It consists of an engraved certificate and $60 in cash. In its award, preference is given to papers describing the construction of completed projects, explaining errors in design and construction and the costs of the work. Joint authors each receive a certificate and share equally in the cash award.

In 1921, the *Engineering News-Record* established and endowed the Arthur M. Wellington Prize for the best paper on transportation by land, water, or air. An engraved certificate signed by the President and Secretary of the Society, and a cash award of $75 go to the winner of this prize, who may be a non-member.

Short biographical sketches of the 1931 prize winners follow.

ALBION DAVIS, M. Am. Soc. C.E., is now Chief Hydraulic Engineer of the Union Electric Company of St. Louis in charge of hydraulic work in connection with the new Osage Development in Missouri. He designed the pioneer installation for using compressed air for relieving ice pressure, and his studies of operating methods at the Keokuk Plant of the Mississippi River Power Company have resulted in definite economies.

FLOYD A. NAGLER, M. Am. Soc. C.E., is Professor of Mechanics and Hydraulic Research at the State University of Iowa, and Director of the Iowa Institute of Hydraulic Research at the university. He has twice won the Society's Collingwood Prize for Juniors. Dr. Nagler has just been elected president of the Iowa Section of the Society.

JOHN R. FREEMAN, Past-President of the Society, was elected to honorary membership in 1930. He has twice been awarded the Norman Medal, and was one of the foremost protagonists of the establishment of a national hydraulic laboratory, recently begun at the Bureau of Standards. Through his generosity a great number of young engineers have benefited by a year of European travel and study in the field of hydraulics.

GEORGE F. SCHLESINGER, M. Am. Soc. C.E., is now Chief Engineer and Managing Director of the National Paving Brick Manufacturers' Association. After five years with the Rock Island Lines he taught at Ohio State University. Since 1919 he has confined his field to highway engineering in Ohio and in 1928 resigned as Director of Highways and Public Works of Ohio to accept his present position. He was formerly president of the Central Ohio Section.

WILLIAM D. HATFIELD, Assoc. M. Am. Soc. C.E., has been superintendent of the sewage disposal plant at Decatur, Ill., since 1924 and was responsible for its investigation, design, and construction, and for the research work carried out in connection with its operation. Dr. Hatfield has held the chair of Physical and Organic Chemistry at Montana State College and is a specialist in the bacteriology and chemistry of sewage treatment.

SAMUEL A. GREELEY, M. Am. Soc. C.E., spent five years in the office and field for the firm of Hering and Fuller on design, reports, and supervision of construction of sanitary engineering works. For three years he was Assistant Engineer of the Sanitary District of Chicago. Since 1915 he has engaged in private practice for improving water supply, sewerage, and refuse disposal methods for municipalities and industries.

Long and Honorable Service Rewarded

The Society Year Book, on page 115 of the 1931 edition, contains a list of members who by virtue of long-continued membership are required to pay no further dues to the Society. By the provisions of Article IV of the Constitution, Corporate Members and Affiliates who have paid dues for 35 years, or who, having reached the age of 70 years, have paid dues for 25 years, are exempt from further payment of dues. Each year, when bills for dues are sent out to members on December 1, there is a larger group of members fortunate enough to be relieved of this obligation. This year the following 73 members are entitled to such special consideration, having passed into this distinguished class:

Arnold, Bion Joseph
Ashbridge, Richard I. Downing
Babb, Cyrus Cates
Bascome, Western Radford
Benfield, Bernard
Boatrite, James Edwin
Brackenridge, John Crosbie
Chambers, Ralph Hamilton
Cohen, Frederick William
Crane, Francis Elihu
DeWitt, Philip Hoffecker
Diebitsch, Emil
Eder, Henry James
Eglee, Charles Henry
Ferguson, Hardy Smith
Gardner, Randall Dunbar
Gilkey, Thomas Alvin
Greene, Carleton
Hall, John Lincoln
Harrington, Ephraim
Harris, Elmo Golightly
Harrison, Edmund Pendleton Hunter
Hedrick, Ira Grant
Higgins, George
Hodgdon, John Brewster
Hough, David Leavitt
Houston, John Jay Lafayette
Hughes, David Edward
Kaltenbach, Henry Julius
Kernot, Maurice Edwin
Lea, Samuel Hill
Leisen, Theodore Alfred
Lewis, Marcus Winfield
Macnab, George Travilla
McKenney, Charles Albert
Mercer, Charles Hatton
Merryman, William Curtis
Miller, Rudolph Philip
Mogensen, Olaf Einar
Mogensen, Peter
Molitor, David Albert
Moody, Burdett
Mozart, William Jacob
Mulholland, William
Neumeyer, Robert Engler
Oxholm, Theodor Smidt
Parsons, Harry de Berkeley
Pratt, Mason Delano
Renshaw, Alfred Howard
Rogers, Walter Alexander
Rohrer, Jacob Bomberger
Shenehon, Francis Clinton
Sjöström, Ivar Ludwig
Smith, Leonard Sewall
Snare, Frederick
Snook, Thomas Edward
Sperry, Henry Muhlenberg
Starrett, Milton Gerry
Stowe, Harold Clair
Sykes, George Whitfield
Talcott, Harry Randolph
Tanabe, Sakuro
Tenney, George Oliver
Tibbals, Samuel Gaylord
Turneaure, Frederick Eugene
Tye, William Francis
Wadsworth, Joel Edward
Wallace, Joseph Harrison
White, James Gilbert
Williams, Edward Gilbert
Winn, Walter Scott
Wright, J. Bodine
Yamaguchi, Junnosuke

These engineers have joined the honored group of five hundred who have in the past achieved this distinction.

Unemployed Engineers Improve Their Time

A fine example has been set by Columbia University in admitting to its engineering classes without fee all unemployed professional engineers. This step was made when the Professional Engineers' Committee on Unemployment of New York proposed the idea.

Red tape has been cut so that applicants must only present a certificate secured from the Engineers' Committee showing that they are accredited members of the profession and that they are without employment due to lack of available work. Class attendance is arranged to suit the individual engineer, and attendance is limited only by the capacity of the lecture halls.

By taking advantage of this generous offer, skilled technical men not only can preserve their morale during a period of enforced idleness, but also can brush up on the engineering principles and practice that may have been unused because of specialization since graduation. This is an example which other engineering schools will consider in connection with the present conditions of widespread unemployment of technical men. It is gratifying that some have already adopted it in one form or another.

Rutgers University to Appoint Research Assistants

Another result of the efforts of local committees to benefit unemployed but ambitious engineers is reported by American Engineering Council's New Jersey Committee on Employment and by the State of New Jersey Emergency Relief Administration. Dean P. H. Daggett of the College of Engineering, Rutgers University, a member of the first-mentioned committee announces that six special Research Assistantships in the College of Engineering have been authorized for the spring term. These assistantships not only provide exception from all tuition fees but in addition carry a stipend of $150.

Four of these assistantships will be for part time work on the following projects: (1) study of the velocity of flow and sedimentation in tanks; (2) study of New Jersey sands for building purposes; (3) study of slag as a material for sprinkling filters; (4) breakdown law for rubber insulated wires. The other two assistants will be assigned to problems to be chosen by the applicants.

It is required that applicants be graduates of recognized colleges of engineering and present a certificate from the New Jersey State Committee of the American Engineering Council, stating that the applicant is worthy of assistance in this emergency.

Opportunity to Develop Inventions

Men who have hesitated to develop their ideas on inventions or new projects because of inexperience or fear of expense, will do well to carry them through to completion, have them patented, and put in salable form. A subcommittee of the Professional Engineers' Unemployment Committee of New York, composed of qualified men, is ready to assist and advise gratuitously such men on procedure, and particularly to help them make the necessary contacts with industry and negotiate the sale of patents or rights. At the same time engineers having the ideas and the spare time should conduct researches in technical processes or in methods of construction, transportation, or other work, which they believe from past experience might have practical possibilities.

Dollar-Matching Improvement Programs

The New Jersey State Legislature has provided funds to the limit of allotments, to meet dollar for dollar any sums paid out by local governmental units for labor or personal services. The purpose is to prepare public works programs in every community. Tasks will range from city planning studies to road and street repairs and the remodeling of public and semi-public buildings. Other objectives are grade crossing eliminations, street widening and beautifying programs, and plans and estimates for future highway work.

Topographic Mapping Offers Opportunity

Of wider application is the plan that is now taking shape, to carry out the topographic mapping of unmapped parts of the United States under the provisions of the Temple Act. There is a Federal fund of considerable size which is available and which can be allocated for this mapping, provided the various states will contribute on a dollar-for-dollar basis. In New York and in other states, emergency funds have been appropriated for the relief of unemployment, and these may be used to match Federal funds for the immediate expansion of the mapping program.

Through influential persons in the state departments of their respective states, Local Sections have been urged to search out available appropriated funds which may be used to match Federal funds for this purpose. Such a program will have immediate effect on unemployment relief because fully 80 per cent of the funds appropriated in this manner will be paid in salaries, and mapping work is distinctly engineering work. This mapping project is a logical, legitimate, constructive spending of both tax-raised and contributed funds, the need for which has been recognized not only by Congress but also by the general public.

California Has Engineering Program

An outstanding example of state guided engineering activity is found in California, which has made appropriations totaling over a million and a half dollars for work which will require the service of engineers during the next fiscal year. This work includes stream gagings for flood control studies; maintenance, operation, and emergency protection of the existing flood control projects; supervision of the design, construction, maintenance, and operation of dams; topographic mapping in cooperation with the Government; irrigation investigations; snow surveys; investigation of water resources; and engineering investigations of trans-bay toll bridge projects.

Half a Century of Membership

Fifty years of continuous connection with the Society is a long time, yet there are 24 Corporate Members who have already attained this distinction. Of these, the two oldest in point of membership are Prof. William H. Burr and Prof. Robert Fletcher, each of whom is now in his fifty-eighth year of continuous membership in some grade. In the December issue of 1930, page 215, appeared a short biography of Professor Burr.

Second on the list, but only by a few months, is Professor Fletcher, Director Emeritus, Thayer School of Civil Engineering, Dartmouth College. A graduate of West Point in 1868, he has devoted a lifetime to the foundation, administration, inspiration and guidance of the Thayer School. From its founding in 1871, through his retirement in 1918 and down to the present time, Professor Fletcher has advocated and demonstrated the effectiveness of the five-year engineering course—that is, at least three years of college preparation followed by two years of engineering. For many years he has been president of the New Hampshire State Board of Health, and has served his community in many other ways. Retirement from active teaching has simply meant the diversion of practically undiminished energy from one channel into a number of others.

Since the publication of the previous list of 50-year men, the names of six other well known engineers, who have also gained distinction by reason of service to the profession and to the Society, have been added to make the complete record stand as follows:

William Hubert Burr	Jun., June 1874; Affiliate, May 1880; M., Mar. 1886
Robert Fletcher	Affiliate, Nov. 1874; M., Aug. 1909
Charles Penrose Perkins	Jun., Feb. 1875; M., Apr. 1882
Frederick Billings Howard	Jun., Mar. 1875; M., Nov. 1878
Caspar Wistar Haines	Jun., Feb. 1876; M., Oct. 1891
Henry Newton Francis	Jun., Mar. 1876; M., Nov. 1888
Charles Emery Billin	Jun., Apr. 1876; M., July 1878
Frank Ormond Whitney	Jun., May 1876; M., Jan. 1887
Charles R. Flint	Fellow, June 1876
William Covington Gunnell	M., Feb. 1877
C. Frank Allen	M., Feb. 1878
Percival Roberts, Jr.	Affiliate, May 1879; M., June 1884
Charles Louis Strobel	M., Dec. 1879
John Garret Van Horne	M., Feb. 1880
George Herndon Pegram	Jun., Apr. 1880; M., Jan. 1883; Hon. M., Oct. 1931
Samuel Humphreys Yonge	M., May 1880
George Hume Simpson	M., Oct. 1880
John William Ferguson	Jun., Jan. 1881; M., Feb. 1887
Truman Heminway Aldrich	M., May 1881
Sidney Francis Lewis	M., May 1881
Walter A. Doane	M., Sept. 1881
John Alexander Low Waddell	M., Oct. 1881
Onward Bates	M., Jan. 1882; Hon. M., Oct. 1923

Rudolph Hering Medal Awarded

In 1924 the Sanitary Engineering Division of the Society established and endowed a prize, for which only members of the Society are eligible, which it named the Rudolph Hering Medal. A bronze medal is awarded to the author of the original paper which contains the most valuable contribution to the increase of knowledge in, and to the advancement of, the sanitary branch of the profession. Papers presented to the Society dealing with water works, sewerage works, drainage, refuse collection and disposal, or any branch of sanitary engineering are eligible for this prize. The prize, which has been awarded but once previously, to Harrison P. Eddy, M. Am. Soc. C.E., goes this year to Samuel A. Greeley, M. Am. Soc. C.E., and W. D. Hatfield, Assoc. M. Am. Soc. C.E., for paper No. 1738, "The Sewage Disposal Works of Decatur, Ill." This is the paper that has also been awarded the Thomas Fitch Rowland Prize.

Manual No. 7—Government Services Available to Civil Engineers

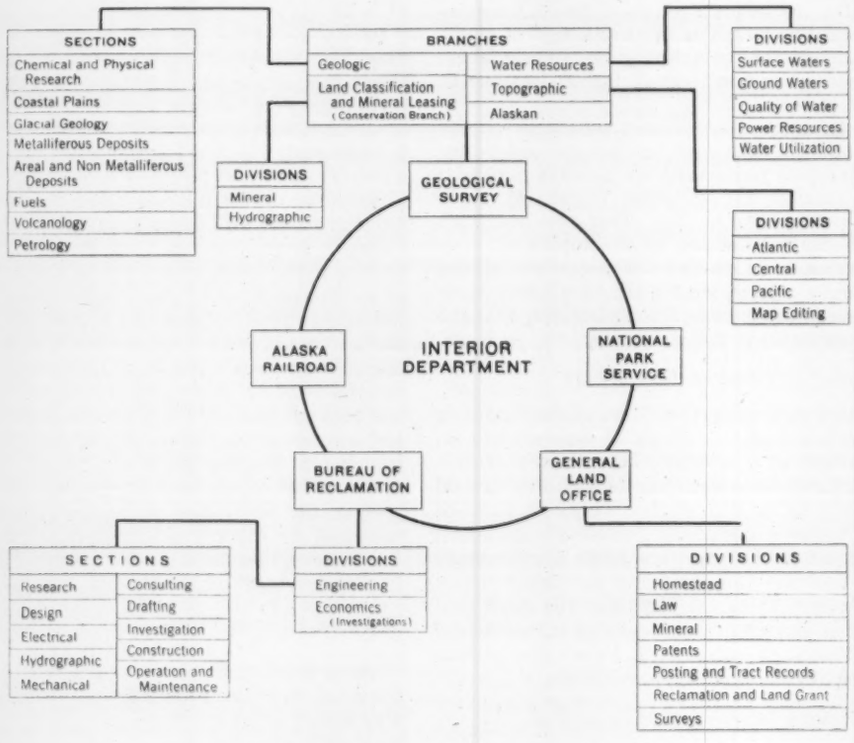
Manual No. 7, of the series of the Society's Manuals of Engineering Practice, just issued, should serve a practical purpose in the case of every civil engineer, inasmuch as it is arranged so as to refer him directly to any Government bureau with which he wants to make contact. An obvious way to arrange reference material such as this would be first to select the Government bureaus and departments that have facilities for serving the civil engineer in his practice. The function and the scope of activities of each of these departments would then be described one after the other in some logical order.

This Manual, however, marks a departure from this method. For example, suppose a certain engineer desires a particular kind of a map. He should then turn to the alphabetized subject index, where under "Maps" he will find a description of map services offered by 11 different offices. A description of the scope of the map service in each department is given directly under this subject heading and no further reading or research is necessary. To balance this layout, a number of organization diagrams serve to lead the inquiring engineer to his subject by way of departmental organizations. In other words, there are two sets of clews.

No pretense is made that this work is absolutely complete. It is, however, complete in all essential details and contains enough supplementary information so that, with one "lead" pointing the way to another, it should be possible, with the least amount of work, for the engineer to get in contact with just the right branch of the Government to cooperate with him in his practice.

The Manual is brief, yet reasonably complete and quite authoritative. It is written necessarily in annotated form, with index headings on the left and code letters or words at the end of each item. The single code word gives an instant clew to the desired Government department. If necessary, reference may be made to the appendix at the end of the Manual, which contains complete addresses corresponding to these code words.

The Manual was compiled and edited by the editor of PROCEEDINGS, with the assistance of the Society's administrative staff, and the cooperation of more than 20 Government offices or individuals, all under the direction of the Society's Committee on Publications. Because of its wide utility, it is being put in the hands of every member, where it is expected to fill a real need.



TYPICAL CHART FROM MANUAL NO. 7
Organization of the Interior Department

Accommodating Discussers in Proceedings

From the number and frequency of inquiries regarding the duration of time within which discussions for papers in PROCEEDINGS are accepted, it is evident that members are not fully aware of the ample provisions made to take care of all those who wish to comment on such papers. According to the standards set up by the Committee on Publications, the general practice is to keep discussion open and active for about three months following the publication of the original paper. It is then hoped that the closing discussion may be published not later than the fourth month. In this way the paper and its comments are fairly close together and there is no clogging of the office machinery through a multiplicity of papers active at any one time.

This schedule, however, is simply an ideal. Circumstances frequently require that the time be changed, usually by extension. It is not uncommon for discussion to run through an entire year. One such paper is now current and the discussions on this particular subject have continued through nine issues of PROCEEDINGS.

Always the policy of the Society has been to encourage discussion. With this in mind, it is customary to accommodate any member who desires some special extension of time, and accordingly to hold the subject open for a reasonable period. Thus it is possible to include all known discussion on any paper.

On the second page of each issue of PROCEEDINGS will be found a list of all the current papers, together with the date on which it is hoped to close discussion on each. Until on this list a paper has been really "closed," there is still an opportunity to include discussion. Members therefore should not hesitate to submit their views up to the time that the discussion is marked "closed." In case of any doubt, an inquiry to Headquarters, with the statement as to how soon the discussion can be submitted, will bring an immediate reply as to its acceptability.

Many minds are better than one and "in the multitude of counselors there is safety." Thus a full discussion of a paper lends a feeling of authority not otherwise obtained. This viewpoint has influenced all the publication policies of the Society for many years, until it has become almost second nature to associate the idea of discussions with the thought of PROCEEDINGS as a vehicle of engineering thought.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

REGISTRATION OF ENGINEERS

An official expression obtained by the American Engineering Council from professional organizations among its member bodies on the question of registration of engineers has resulted as follows:

Favorable to registration: The American Institute of Consulting Engineers, the American Institute of Agricultural Engineers, the American Society of Civil Engineers.

Unfavorable to registration: The American Institute of Chemical Engineers, and the Society of Industrial Engineers.

Non-committal: The American Institute of Electrical Engineers, and the American Society of Mechanical Engineers.

STATE COMMITTEES ON ENGINEERS AND EMPLOYMENT

In accordance with the plan sponsored by the American Society of Civil Engineers through the American Engineering Council, 48 regional committees in 44 states have been organized and in general are diligently at work on the engineering employment program. The following are important extracts from the communications that have been sent to each committeeman:

"*Duplication of Effort.* It is desirable to refrain from engaging in any activities which are being adequately handled by other agencies. To avoid this, the chairman of each state committee or local subcommittee, should at once, upon the formation of his committee, notify the representatives in his state or locality of the President's Organization on Unemployment Relief, of the membership of his committee and offer his cooperation. The same procedure should be followed in such states as have organizations set up by the governor of the state. In some states and localities it may be desirable for the engineer committee, either state or local, to become a subcommittee of the governor's or mayor's committee, to the end that there may be the maximum of cooperation and coordination.

"The chairman of each state committee should immediately contact with all state and local engineering societies and sections of the national engineering societies, asking their assistance, suggesting the appointment of subcommittees to function in their respective localities under the guidance of the state committee.

"*Two Phases of the Program.* The program has two phases which require entirely different plans and different methods of approach. These phases are:

"(*a*) The Emergency Unemployment Relief Plans
"(*b*) The Employment Stabilization Plans

The first, (*a*), is at present the most important and perhaps in most states will command all the committee's attention. However, the ultimate goal of this program is to bring to bear on the problems of employment stabilization the united thought of the engineering profession. Such combined thought and experience are certain to be helpful."

Among the suggestions offered the state committees, certain ones should be emphasized:

"*A. Made Work.* This means actually to create work. This is easy enough in almost any community, as illustrated by Grand Rapids, Mich., Wilmington, Del., and other places. There is plenty of work to be done—the difficulty is to find the funds with which to pay for it. These have been found in communities by

"(*a*) Special tax assessments
"(*b*) Special bond issues
"(*c*) Public subscriptions
"(*d*) Relief funds—money is being obtained in some cities for made-work, work for engineers and others, from the Community Relief Fund

"*B. Public Works.* This means the speeding up and prosecution of worthy needed public works which have been authorized and for which money is available through regular channels. In many instances such projects are being delayed for inconsequential reasons, which an engineer committee may remove without great difficulty.

"*C. Contemplated Public Works.* Every member of each American Engineering Council State Committee is being placed on the mailing list of the President's Organization on Unemployment Relief to receive the daily and weekly release of all contemplated public works projects in the United States. These lists should prove to be helpful. They offer leads for engineers who are unemployed. Other names can be added to the mailing list.

"*D. Spread Work.* This is an extreme emergency measure, predicated upon the assumption that wherever there is a job, this job can be divided or shared. Many lines of activity are such that changes can readily be made in the number of days per week employed, or the number of hours per day may be decreased so as to give employment to additional men.

"This also suggests the possibility of checking up on the hours of employment in many municipal and state organizations. One state committee has found that certain municipal plants work their employees 56 hours per week and require others to be on call 24 hours per day, 7 days a week. This practice may exist in other states. An effort should be made to have the hours worked per week reduced so more men may be employed. State committees can do this by bringing to bear the weight of public opinion."

CONGRESS IN SESSION

As this item goes to press Congress is meeting in Washington, D.C. The Democrats have organized the House, and the Republicans have a precarious majority in the Senate. The president has presented his message, which deals largely with the financial conditions of the country, which are of more than general interest to civil engineers, but it also contains several recommendations relative to Muscle Shoals, the St. Lawrence Waterway, and the establishment of an Administration of Public Works. Several thousand bills have already been introduced.

Due to a more effective liaison having been established, American Engineering Council will report the progress of these matters of vital concern to civil engineers through this column each month.

HOOVER DAM PUBLIC INFORMATION COMMITTEE

The Associated General Contractors of America, under the leadership of A. P. Greensfelder, M. Am. Soc. C.E., have formed a committee known as the Hoover Dam Public Information Committee. The committee will issue information correctly to inform the public of the status of this gigantic project, the working conditions, and the general procedure surrounding it. This committee is composed of the following:

Consulting Engineers:

B. L. Brown, M. Am Soc. C.E., St. Louis.
H. S. Crocker, M. Am. Soc. C.E., Denver.
J. B. Lippincott, M. Am. Soc. C.E., Los Angeles.

Consulting Constructors:

A. S. Bent, Affiliate Am. Soc. C.E., Los Angeles.
A. E. Horst, M. Am. Soc. C.E., Philadelphia.
George B. Walbridge, Detroit.

Detailed Annual Meeting Program Appears in This Issue

Publication of the Annual Meeting program in this month's issue of CIVIL ENGINEERING is a new departure. For years a 4 by 8 1/2-in. folder has been the standard program for all Society Meetings.

A brief summary of the main events of the program has been mailed to each member, together with a registration card and a railroad certificate. But, in addition, reprints of the schedule of events as it appears in this issue are available to any member upon request to Society Headquarters. Separate copies will also be on hand at the time of the Meeting for the convenience of those in attendance. These can be easily folded to slip into a pocket for ready reference.

A Preview of Proceedings

Five papers on three separate and distinct subjects make up the major content of the January issue of PROCEEDINGS. *In the first paper, dealing with the efficient design of riveted connections for structural members, it is explained that such connections should be designed so that every part will have its full share of load-carrying ability. The next two papers, which form a symposium, discuss the need for state supervision of the design, construction, and maintenance of dams to prevent failures. Such supervision is recommended and model wording is given for a unified law based on the police power of the individual state. The fourth paper explains the applications of tereoscopic measuring and plotting instruments to photo-topographic mapping, while the last opens the general subject of dams, describing the analytical method of designing the gravity sections and buttresses of slab dams.*

WIND BRACING CONNECTION EFFICIENCY

In his paper on "Wind Bracing Connection Efficiency," U. T. Berg, Assoc. M. Am. Soc. C.E., has outlined a method and developed formulas for the determination of tension in rivets, for the effective lever arm of connections, for the rotation of joints, for joint equilibrium, and for horizontal deflection such as side sway. These formulas are given for the connections commonly in use. Flange angles, sheared angles, and sheared I-beam connections are thus described. The author demonstrates the lack of security in the present method of designing rivets. For example, he shows how a stress of 18,000 lb. per sq. in. on rivets, as used by many designers, may actually become twice that amount. The paper lays particular emphasis on the importance of analyzing the relative strengths of the various parts of the connection, and Mr. Berg sounds a solemn warning against making rivets the "weakest link."

To design bracing for wind loads alone, without regard to the effect of gravity load, especially when the wind loads are comparatively small, is shown to be a dangerous practice. The paper discusses such significant subjects as : tension rivets, flange angle connections, sheared channels, sheared I-beams, behavior beyond the elastic limit, rotation from deformation of connection, and the relative behavior when the connection is stressed up to the elastic limit.

PUBLIC SUPERVISION OF DAMS—A SYMPOSIUM

RECOMMENDATIONS FOR LEGISLATION AND FOR APPLICATION OF LAW

In his paper on state supervision of dams, A. H. Markwart, M. Am. Soc. C.E., urges the engineering profession to turn its thoughts seriously to ways and means of preventing the failure of dams. One important method is to provide intelligent state supervision of their design, construction, and maintenance because, quoting from the report of a recent disaster, "the construction and operation of a great dam should never be left to the judgment of one man, no matter how eminent."

The treatment of the paper is decidedly impartial. The author describes the characteristics of the best types of supervision. He recommends the extent to which the state should be given power of supervision and discusses the effect of state supervision on the cost of dams. The paper closes with a few significant comments on the feasibility of creating a standard building code for dams.

NECESSITY FOR, AND PENALTY FOR LACK OF, PUBLIC SUPERVISION

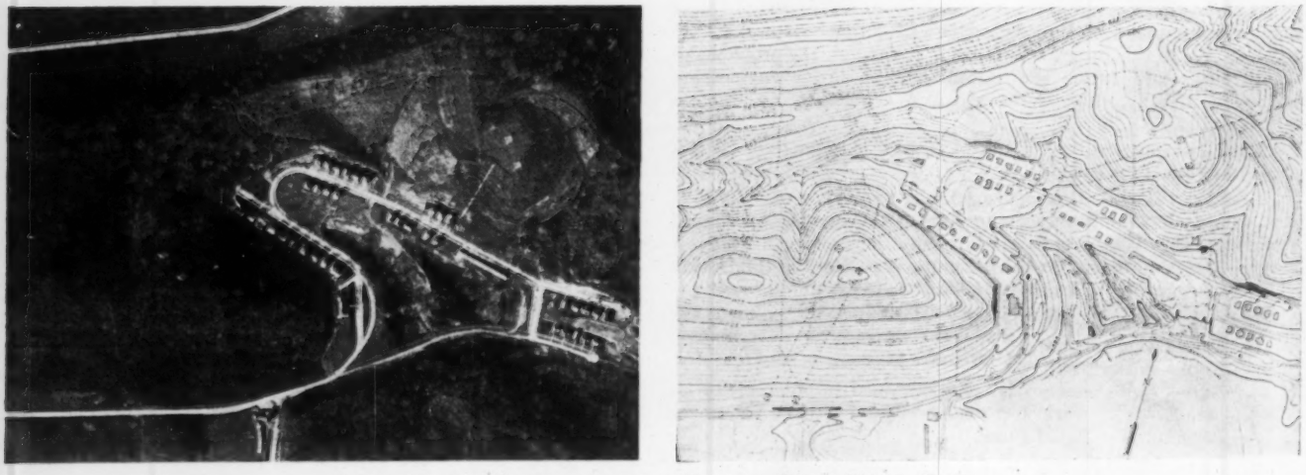
The second paper of this symposium is a review of existing provisions and suggestion for a unified code, by M. C. Hinderlider, M. Am. Soc. C.E., who presents the viewpoint of a state engineer. Moreover, while Mr. Markwart is interested in discussing what a law for state supervision should include if it were enacted, Mr. Hinderlider is interested in urging the enactment of such a law and in recommending specific clauses which it should contain. The last-mentioned paper begins with a summarized list of failures and the reasons for them. The author interprets this table and advocates the general adoption of the principle that safety is of such concern to the general public, and therefore to the state, as to necessitate bringing the supervision of dams within the scope of the police power.

A study has been made of the laws for the supervision of dams in each of the states of the Union and of the separate bureaus of the Federal Government, as well as of numerous European countries. The paper by Mr. Hinderlider closes with an itemized list of suggestions for the framing of the laws to supervise dam construction. Another list outlines the advantages and disadvantages of state control of such structures. Finally, the author makes suggestions for qualifications of supervising officials.

It is hoped that these two papers, with their discussions, may serve to awaken a general interest in this subject and to form the nucleus of a mass of material for use in framing a unified code for the supervision of the design, construction, and maintenance of dams.

STEREO-TOPOGRAPHIC MAPPING

In "Stereo-Topographic Mapping," C. H. Birdseye, M. Am. Soc. C.E., describes a thoroughly modern surveying method. Briefly but in detail he explains the adaptation of the aerocartograph to—draw a deep breath—stereophototopographic mapping. Before dealing with his subject intimately, Colonel Birdseye introduces, by means of brief descriptions and photographs, some of the more common types of stereoscopic measuring and plotting instruments. The paper will also be found valuable for its exposition of the fundamental principles upon which such instruments are based. A detailed description of the theory of the aerocartograph is given in the hope that discussion will disclose basic differences between this instrument and others of similar type now in common use.



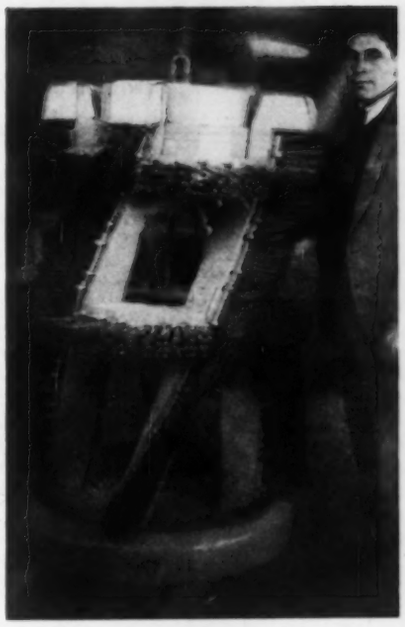
AERO-TOPOGRAPHIC SURVEY OF A PART OF FORT MIAMI PARK
Left, the Photograph; Right, the Completed Map, Both to the Same Scale

Determination of Principal Stresses in Buttresses and Gravity Dams

In contrast to the graphical or semi-graphical methods of designing gravity dams and buttresses is the analytical method described by W. H. Holmes, Assoc. M. Am. Soc. C.E., in his paper entitled "Determination of Principal Stresses in Buttresses and Gravity Dams." His formulas are based upon the classical formulas first derived and introduced by the late William Cain, M. Am. Soc. C.E. The author states that if Professor Cain's analyses were made more general and were extended to include the vertical component of the water load on gravity dams, straight or arched in plan, or on the tapering buttresses of multiple-arch dams, the arithmetical work would be extremely laborious. The studies made by Mr. Holmes, as described in this paper, indicate that the ordinary method of determining the vertical normal stress at the heel and toe of high dams is not sufficient for complete analysis. The purpose of the paper is to contribute some suggestions for improvement along this line.

The paper is divided logically into the discussion of dams in three groups: first, gravity dams straight in plan; second, gravity dams arched in plan; and third, buttresses of flat-slab or multiple-arch dams with rectangular horizontal sections that taper with the height. Application of the equations is illustrated by several numerical examples.

In conclusion, Mr. Holmes states that these examples indicate the fallacy of the middle-third theory as a safe criterion for dam design. The paper closes with five specific conclusions, as follows: (1) the proposed method provides an exact and concise means of determining maximum stresses; (2) it gives complete internal stress analysis; (3) it indicates that the monolithic section only should be used when determining the section modulus of the base; (4) it suggests a method of designing buttresses to eliminate tension; and (5) it makes available a basis for the design of contraction joints.



"Go-Devil" Designed to Clean the 32-Mile La Ole Pipe Line

Closing Discussion on La Ola Pipe Line

In the September 1930 issue of PROCEEDINGS, W. B. Saunders, M. Am. Soc. C.E., described the construction of the 32-mile La Ola pipe line built for the Andes Copper Mining Company in Chile. The interesting phases of the work were the fabrication of riveted steel pipe in the field and the transportation of all materials by mule cart. In the January issue, Mr. Saunders answers discussers and summarizes his paper, adding a few remarks on operating experience. The "go-devil" pictured here, which was devised to clean the line, is described in detail.

News of Local Sections

Arizona Section

At the annual meeting of the Arizona Section, held in Phoenix on November 14, F. C. Kelton was elected President for the coming year and G. L. McLane, Vice-President.

Central Ohio Section

On November 12 the Central Ohio Section held its annual meeting, at which 26 members and guests were present. The following officers were elected for the coming year: R. A. Allton, President; W. H. Knox, First Vice-President; C. B. Hoover, Second Vice-President; R. R. Litehiser, Secretary-Treasurer. An interesting talk on the "Rural Sanitation Program in Southern Ohio as a Result of the 1930 Drought," was given by F. H. Waring, Chief Engineer, Sanitary Engineering Division, Ohio Department of Health. Many interesting points concerning the sanitation work being carried on in Southern Ohio were brought out by Mr. Waring.

Colorado Section

A luncheon was given by the Colorado Section on November 2 in honor of the Colorado River Consulting Board. The feature of the occasion was a talk by R. F. Walter, Chief Engineer of the Bureau of Reclamation, who gave a brief outline of the progress of the work on the Hoover Dam.

On November 10 the Section had charge of the Engineering Council luncheon, at which Dean E. G. Plowman, of the Extension Department of Denver University, gave an interesting and comprehensive talk on "The Importance of the Disarmament Conference."

The Section's 206th regular meeting was held on Thursday, November 12, with 60 members and guests present. The guest of honor was Col. H. S. Crocker, who gave an entertaining talk on his recent trip to Texas and the East. At the close of Colonel Crocker's talk S. T. Weller, Inspector of the Eleven-Mile Canyon Dam, being built by the Denver Board of Water Commissioners, gave an interesting talk on the progress of the work on the dam.

Dayton Section

The first regular meeting of the Dayton Section, on Monday, October 12, consisted of a luncheon and inspection trip through Wright Field, which is the largest aviation depot in the country.

The November meeting of the Section was held on Monday, the ninth. At this time Fred J. Cellarius, a consulting engineer in Dayton, gave an outline of the Civic Center Project as proposed by him. The attendance at this meeting was 24.

Metropolitan Section

Long Island's expanding state park system was the subject of discussion at the December 16 meeting of the Metropolitan Section. Present parks and parkways and those projected for the near future were described by Arthur E. Howland, Chief Engineer, and W. E. Andrews, Deputy Chief Engineer of the state system; and Robert Moses, president of the commission, spoke on the broader aspects of the commission's problems. Ultimately it hopes to have 5 per cent of Long Island, or 40,000 acres in parks. At present it has 17,000 acres.

In so far as possible, the commission is endeavoring to make the project self-supporting through income from concessions and bathing facilities. The income from Jones Beach in 1931 was $691,000; $900,000 is expected in 1932, or two-thirds of the cost of maintenance of the system.

J. Spencer Smith, president of the American Shore and Beach Preservation Association, spoke on the problem of maintaining beaches along the Atlantic seaboard.

Over 400 members and guests were present. At the close of the meeting light refreshments were served.

Portland Section

An illustrated discussion on pre-manufactured concrete was given at the October meeting of this Section, by Porter Yett, Manager of Swigert-Hart and Yett, Inc. Moving pictures of recent concrete jobs in the Portland area were shown, and also pictures of concrete work on the St. Johns Bridge.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for February

A PLEA for beautification of structures, especially bridges, is made in an article prepared by Frank B. McKibben, M. Am. Soc. C.E., to appear in the February issue. His method of presentation is unique. It consists of an exposition of the value of a knowledge of fine poetry. For, he asks, if a designer has an appreciation of poetry, will it not find expression in his structures? Professor McKibben believes that it will and cites a number of examples of beautiful bridges that have been the inspiration of such men as Robert Burns, Henry Wadsworth Longfellow, and Eugene Field.

Another article will present a practical method of making a survey of the odors emanating from a sewage disposal plant. This is by H. L. Thackwell, Assoc. M. Am. Soc. C.E. At best, waste disposal plants are blamed for every obnoxious odor within a five-mile radius. Often the actual cause of the odor can be traced to an unsanitary condition existing even on the property of the person making the complaint. The survey described in this article was carried out in Jacksonville, Tex.

Proportioning of concrete in a scientific manner has been practiced for years, but laboratory procedure needed to be reduced to practical methods for use in the field. The control of concrete—the laws of mixtures and their application—is the subject of an article by Joseph A. Kitts, Assoc. M. Am. Soc. C.E., entitled "Proportioning Concrete Made Simple." A number of practical tables are given to simplify the proportioning calculations for the design of concrete of a given strength, when tested aggregates and a given amount of water are used.

In France, concrete arch spans have been built exceeding in length those built anywhere else. A number of these notable spans were designed and built by E. Freyssinet, who originated a system of construction and a theory of design for long-span reinforced concrete arches. Of these the most remarkable is the Plougastel Bridge near Brest, named the Albert Louppe Bridge, which consists of three 612-ft. arches.

A paper read by Mr. Freyssinet before the First International Congress for Concrete and Reinforced Concrete at Liege, Belgium, has been translated and reviewed for CIVIL ENGINEERING by J. T. Thompson, M. Am. Soc. C.E., of Johns Hopkins University. In this article is explained the basis of a theory which, according to Mr. Freyssinet, makes possible the construction of safe reinforced concrete arches 5,000 ft. long.

Other articles—one on the relation between tree rings and rain fall, and another economically comparing bridges and tunnels—are planned for the February issue.

Hydraulic Laboratory at the University of Iowa

IT IS ANNOUNCED that the hydraulic laboratory at the University of Iowa has just been organized as the Iowa Institute of Hydraulic Research. This laboratory, located on the Iowa River near the University, was originally constructed in 1919 and 1920 and since has been extended and enlarged. Suitable quantities of water are available for channel experiments and an elevated tank in the four-story laboratory building provides facilities for model experiments

Since its construction this laboratory has been in continuous demand for hydraulic investigations and research in cooperation with Federal departments, municipalities, engineering companies, and industrial organizations. By its organization as a part of the state university, greater opportunity will be afforded for the coordination of all the talent at the university with that from the engineering offices of private and public organizations desiring to undertake research work. An advisory committee of prominent practicing hydraulic engineers has been named to assist in giving practical engineering value to the researches carried out.

If I Were Dictator

IN *The Nation* for November 18, page 536, appeared an article entitled "If I Were Dictator" by Stuart Chase, who has written much on the popular side of national problems in economics. The engineer has often been mentioned in connection with Mr. Chase's literary excursions into "vital" economics. Apropos of the engineer's part in relieving unemployment, this article, written as if the author were the national dictator, contains the following quotation:

"I shall cause to be issued from $3,000,000,000 to $5,000,000,000 in Prosperity Bonds, for the purpose of immediately utilizing a million or more unemployed on public works. As I understand it, the blue prints for the useful expenditure of huge sums are already in the files of the federal engineers, and work may be started any day without waste or lost motion. Highways, waterways, public buildings, power-site development, flood control, afforestation, slum clearance, construction of great recreational centers—these will be among the chief projects. The chemical division of the sometime army I shall turn loose on the mightiest war against insect pest and parasites any nation has ever known. Bugs, beetles, bacilli will be driven to the last ditch with flame and gas and poison. . . .

"I think I shall make Mr. L. R. Smith of Milwaukee, the man who employs 600 engineers and 7 salesmen, chairman of this committee [a sub-committee, working as a part of Mr. Chase's general organization]. . . .

"When everything is running a smoothly as one could hope I will appoint a permanent board of managers, preferably from the engineering profession, and retire."

Transportation Fellowships Offered at Yale

FIVE FELLOWSHIPS, open to graduates of institutions of recognized standing, are being offered by the Yale University Graduate School. Five Strathcona Memorial Fellowships in Transportation, of $1,200 each, are offered annually for advanced work in transportation, with special reference to the construction, equipment, and operation of railroads, and other engineering problems connected with the efficient transportation of passengers and freight, as well as the financial and legislative questions involved. Transportation by water, highways, or airways, and the appropriate apparatus needed, and also other general aspects of the broad field of transportation, embracing its legal and economic phases, will be included in the list of subjects which the fellows may select for investigation and study.

In making the award, preference is shown, in accordance with the will of Lord Strathcona, to such persons or to the sons of such persons as have been, for at least two years, connected in some manner with the railways of the Northwest.

Applications for these fellowships should be addressed to the Dean of the Graduate School of Yale University, New Haven, Conn., before March 1, on blanks which may be obtained from him.

Graduate Engineers Seek Cultural Courses

MORE THAN 250 graduate engineers of the Polytechnic Institute of Brooklyn have enrolled for the Institute's course in applied psychology. Under a unique plan, the Institute is offering its graduates a free course each year in any field which they feel it most profitable to pursue. When the offer was made, its sponsors believed but few would take advantage of it, and that those who did would select work in their immediate fields for further scholastic research.

This proved not to be the case. Practically every alumnus of the college who applied, wished to undertake study in humanistic or cultural fields. Nearly all the men expressed eagerness for a course in applied psychology. Second in popularity was public speaking, and

others registered for courses in modern drama and literature. Surprisingly few asked for further training in either pure or applied science. Five times the expected number of alumni have already enrolled.

Should Your Boy Be An Engineer?

A YEAR AGO in October the Engineering Foundation created the Education Research Committee, composed of seven members, one nominated by each of the four Founder Societies, and one each by the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the Engineering Foundation. The results of the activities of this committee have been spread through numerous channels and three objectives have been decided upon as worth achieving:

1. Camps for acquainting boys with professional vocations
2. The development and practical appraisal of achievement and aptitude tests
3. The use of pamphlets, articles, and books for boys, parents, and teachers to spread authentic information on engineering as a career

As a pioneer venture, the Stevens Institute of Technology conducted a camp for two weeks last August to help the 40 boys who attended in making a proper decision. The facilities and equipment which had been used by the freshman surveying camp during the preceding six weeks were made available to the boys. With three daily swimming periods, a good mess hall, and plenty of sports both indoors and out, a healthful background was created for the main purpose of the camp.

In the words of President Harvey N. Davis of the institute:

"One of the most important decisions in a boy's life is his choice of a college, not so much his choice of a particular college, for there are many groups of similar colleges any one of which is as good as any other, but rather his choice of a type of college. Whether he chooses a liberal arts college on the one hand or an engineering or scientific college on the other, does much not only to determine the probable nature of his future life work but to fashion the very warp and woof of all his reactions to, and appreciations of, the whole of modern civilization. Every boy should make this choice not solely on the basis of his personal associations and family traditions, but rationally and intelligently, in the light of all he can find out about his own aptitudes, skills, and interest patterns, and also about the various professions and occupations to which these two types of college training naturally lead. . . .

"The serious work of the camp consisted of three parts: first, a group of lectures on choosing a college, on choosing a career, and on what various kinds of engineers do, not only in their inspired moments, but also in the ordinary routine of their daily lives; second, an opportunity to see what one simple variety of engineering activity actually feels like, through four and a half hours a day in the field learning the rudiments of surveying; and third, an opportunity to study their own aptitudes, skills, and interests through a comprehensive set of psychological tests administered and interpreted by experts. . . .

"On the psychological side, 13 tests were given to each boy, including Johnson O'Connor's aptitude tests, the Iowa Scientific Aptitude Tests, the O'Rourk Mechanical Aptitude Test, one form of the Otis Test, and the Strong Interest Blank. The results were interpreted to each boy and to his parents in the light of the intimate impressions of the various squad leaders who lived with their boys 24 hours a day, and of the revealing personal letters that had previously been received from parents and headmasters. Advice was freely given, but it was stressed that the final decisions should be made, not by us, not even by the parents, but by the boys themselves.

"It is interesting to note that the boys' reactions to these tests were so generally cordial that many of them on their own initiative took a number of other tests that were not being used with the group as a whole. Indeed, by the end of the two weeks, nearly half the boys had taken as many as 27 different tests to satisfy their own curiosity about themselves. . . .

". . . the experiment is well worth trying again next summer. Indeed we hope that other colleges will also try it, not only in engineering but in other fields, such as biology and medicine, geology and mining, the fine arts, and perhaps even in sociology and law."

The results of this comprehensive educational experiment at Stevens Institute will be watched with interest by engineers who have boys to educate.

Eads Bridge Arches Not Closed by Use of Ice

BUILT across the Mississippi River at St. Louis, the Eads Bridge was opened to rail and highway traffic in 1874. It is composed of three steel arch spans, the central one 520 ft. long, and the two side ones 502 ft. each, from skewback to skewback. The construction, at that time, of a bridge of such unprecedented dimensions required remarkable skill, courage, and energy on the part of the late James B. Eads, M. Am. Soc. C.E., Chief Engineer, and his staff. It also taxed the ingenuity of the company (headed by Andrew Carnegie) which furnished the steel and of the contractors who erected it, the Keystone Bridge Company. Seven years were consumed in its construction.

Many complicated problems arose in connection with the building of this monumental structure—among them those relating to the construction under compressed air of the cofferdams for the piers, and the cantilever erection of the arch ribs, which were supported by hold-back cables. A much discussed matter even to this day is the exact part that the use of ice played in obtaining the closure of the

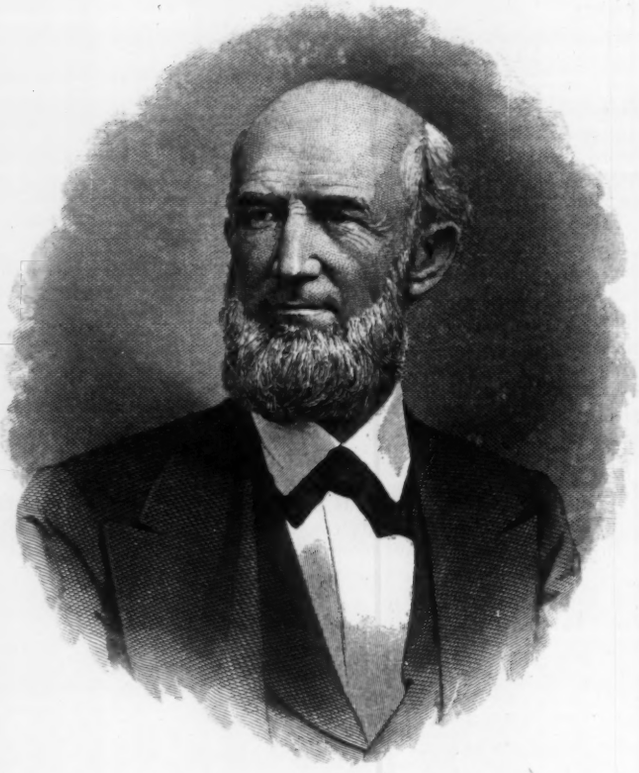
METHOD OF ERECTING THE EADS BRIDGE

Reproduced from C. M. Woodward's *A History of the St. Louis Bridge*

arch ribs on the west span during the night of September 17, 1873. Correspondence from members has indicated the desirability of obtaining the facts in regard to this closure. With the assistance of George H. Pegram, Hon. M. Am. Soc. C.E., the account which follows has been prepared.

For the arches of the bridge, Captain Eads decided to use steel rolled into bars about 12 ft. long, of such form that six bars would fill the inside circumference of an 18-in. riveted tube, 1/4 in. thick, in the way that the staves of a barrel fill the hoops. The thickness of the staves, as they were called, varied from a little over 1 in. to a little over 2 in. The result was a hollow steel tube, much less expensive than one rolled or drawn in one piece. The steel bars, being enclosed in tubing, were effectively protected from the weather. The tubes were to be held in position by a system of bracing, the tube sections to be fitted end to end and held together by means of locking grooves and a bolted coupling.

Each length of tube was made slightly longer than its final calculated length under the compression of full load on the bridge. When the closure of the tubes at the crown of the arch was undertaken, the accumulated excess length of the individual pieces—together with some error in alignment due to unequal strains in the diagonal bracing, and expansion due to temperature changes—made it impossible to fit the closing tubes into place. It was determined by the late Henry Flad, M. Am. Soc. C.E., Captain Eads' principal assistant, that the ordinary tubes could be inserted if the temperature of the arches could be held down to 44 deg. fahr. It was then September 14, 1873, and there was no time to lose, for a loan which was being negotiated by Captain Eads in London was contingent on the closing of the first arch by September 19.



Jas. B. Eads

The weather continued unfavorably warm, and the variation in the gap between the semi-ribs from temperature amounted to 2 1/4 in. It was thought by Colonel Flad that the closure could be effected by the use of ice. All tubes of the inner ribs over both halves of the span were covered with burlap and saturated with river water. Boards were then laid on edge along each side of the ribs to form a continuous trough, which was filled with ice. Fifteen tons were placed in the troughs on September 15. However, the weather remained warm, the air temperature reaching 98 deg. in the shade at 5 p.m., and the closure still lacked 5/8 in. at daybreak of September 16. More ice—45 tons—and more water were applied all during the sixteenth but at sundown the opening lacked 1 1/8 in. During the night of the sixteenth a warm wind blew and in the morning there was still a deficiency of 3/4 in. There being no prospect of a change to cooler weather within the time available, the "ice poultice" was abandoned on the morning of the seventeenth.

ADJUSTABLE CLOSING TUBES

The actual closure was made by substituting for the plain tubes, adjustable

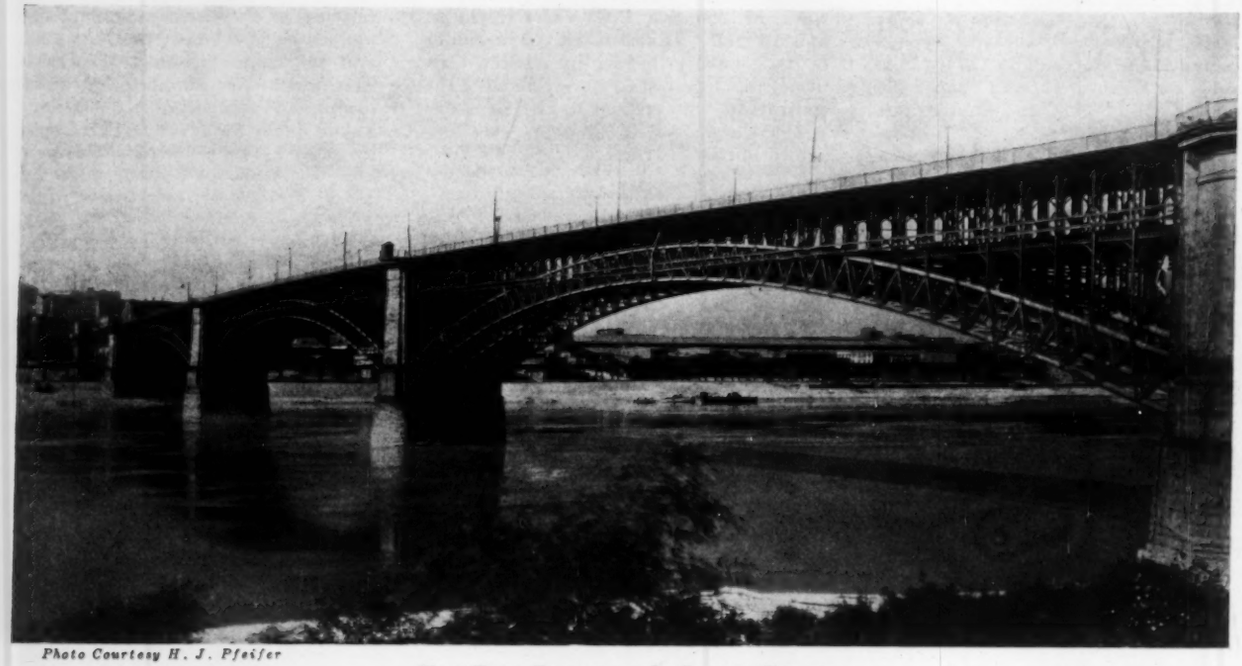


Photo Courtesy H. J. Pfeifer

THE EADS BRIDGE AS IT STANDS TODAY
Bridge, Tunnels, and Approaches Together Cost $10,000,000

ones which Captain Eads had had made previously, in accordance with a special design of his own. According to this design, a 5-in. piece was cut out of the middle of ordinary final tube sections, and in place of it a threaded cylindrical connection was inserted. A righthand thread was cut on one end of this connection and a lefthand thread on the other. These threads engaged similar right and lefthand threads inside the severed ends of the original tube. Thus these substitute tubes could be shortened for insertion at the crown of the arch and expanded to raise the completed arch to its final position. The right and left threaded section fitted inside the regular tube section, and after final adjustment in the length had been made, the space between the ends of the tube was exactly filled with a ring section so that the tube section would be continuous.

Insertion of the special tubes was effected with very little difficulty. The closing tubes for the lower ribs were inserted first in the hope that a rising temperature would place sufficient compression in the lower arch ribs to increase the opening in the upper arches. The space only increased 1/8 in., however, and by 4 p.m. on September 17, the upper closures were also effected by means of the adjustable tubes. The final bracing was then put in place. The next morning, September 18, a telegram was sent to Captain Eads in London: "Arch safely closed. Last tube at nine yesterday. Flad." The loan was made.

The use of ice might have been successful had it been possible to encase the entire rib in it. However, the "ice poultice" was not successful; and the river water, which was at 72 deg., was not effective either. A plan to discharge a stream of compressed air into each skewback tube was considered in the belief that the expansion of the air would extract enough heat from the steel to produce the desired contraction. This method, however, was not tried, and final closure of all subsequent arches was successfully effected by using the adjustable tubes.

For the line cuts and for other material here used acknowledgment is made to the monumental work entitled *A History of the St. Louis Bridge*, by the late Prof. C. M. Woodward, one-time dean of the Polytechnic School of Washington University, at St. Louis. It was published in 1881 by G. I. Jones and Company of St. Louis. The accuracy of Professor Woodward's descriptions and explanations was attested to by Captain Eads himself.

NEWS OF ENGINEERS

From Correspondence and Society Files

GEORGE R. RICH is now employed by the U.S. Engineer Office in Boston, on the Cape Cod Canal improvements. Prior to this, he was an engineer in the hydraulic division of the Stone and Webster Engineering Corporation.

JOHN OSMOND TOERNER, Chief Draftsman and Estimator of the Nelson and Landgren Company, Inc., in Brooklyn, was formerly Estimator for the Grand Iron Works, Inc., of New York City.

R. A. SMALLMAN, formerly Vice-President and Treasurer of the Smallman-Brice Construction Company, Inc., is now President of the Smallman-Mac Queen Construction Company, Inc.

A. P. DAVIS, who has recently returned to California from a two-year engagement in Russian Turkestan, has been appointed to the consulting board of the Metropolitan Water District of Southern California, which is to advise on the construction of the Colorado River Aqueduct.

T. R. LAWSON, head of the Department of Civil Engineering, Rensselaer Polytechnic Institute, has been elected Vice-President of the American Society for Testing Materials to fill the vacancy caused by the death of S. T. WAGNER, Consulting Engineer of the Reading Company.

ARTHUR L. DAVIS, who has been at the American Bridge Company's New York office, as General Contracting Manager, has recently been appointed Vice-President and has moved to Pittsburgh.

EDWIN C. HOLBROOK is now associated with the Pacific Commercial Company, in Manila. Formerly he was an engineer in the Foreign Trade Division of the Truscon Steel Company, in New York City.

CARLTON E. HUNT, who in the past has been Cost Engineer for Dwight P. Robinson and Company, Inc., has become associated with the United Engineers and Constructors, Inc., in Philadelphia.

JAMES N. GLADDING recently accepted the position of City Manager of Albuquerque, N. Mex. Prior to this, he was an Architect and Engineer in Albuquerque.

HARRY B. THORN, Contracting Engineer for the McClintic-Marshall Corporation, in Bethlehem, Pa., was formerly Assistant to the Manager of Sales of the Bethlehem Steel Company.

G. A. DENHAM has accepted a position with the Louisiana Highway Commission as a bridge inspector.

C. D. RIDDLE, previously associated with Allied Engineers in Birmingham, Ala., has recently become connected with Furman Shoals Dam, in Milledgeville, Ga.

G. C. LIGHTNER has been appointed Factory Superintendent of the General Aviation Manufacturing Corporation, and has been transferred from Wheeling, W. Va., to the company's new plant just outside of Baltimore.

C. H. RIGHTMIRE, City Engineer of Enid, Okla., was prior to this a division engineer for the State Highway Commission.

E. J. MCGREW, JR., previously a contracting engineer with the Baily-Davis Corporation, of New York City, is now affiliated with Swart-Brent and Company of the same city.

CHARLES R. THOMAS, JR., at one time Engineer-Executive, City Officials Division of the American Road Builders Association, is now Publicity Director for that association.

D. H. YOUNG has accepted an instructorship in engineering mechanics at the University of Michigan.

WILLIAM STANLEY PURCELL, an inspector for the Public Service Commission of New York City, was previously an assistant engineer for the Trojan Engineering Corporation, also of New York.

R. A. STURGEON, until recently a resident of Harrison, Ark., has moved to Cairo, Ill., where he is connected with the U.S. Engineer Office.

HOWARD F. PECKWORTH, who has been Principal Assistant to J. C. Meem, in Brooklyn, has finished his work there and is now with the Slattery-Daino Company, Inc., on subway construction work in Forest Hills, N.Y.

A. C. POLK, formerly with the Allied Engineers, Inc., in New York City, is now affiliated with the Alabama Power Company, in Birmingham.

JOHN C. MOSES has accepted a position as Chief Engineer of the Boston Bridge Works, Inc.

WILLIAM S. WILSON, whose residence has been in San Diego, Calif., is now in Beaumont, Calif., where he is connected with the Metropolitan Water District.

JOHN NOLEN, JR., heretofore Assistant Planning Engineer of the Regional Planning Federation of the Philadelphia Tri-State District, has been appointed City Planner of the National Capital Park and Planning Commission, in Washington, D.C.

HARRY P. HART is now affiliated with the Bureau of Public Roads as Assistant Engineer. In the past, Mr Hart was Northwest Representative of the Pomona Pump Company.

WILLIAM S. MITCHELL terminated one of the most colorful and extended careers of any civilian engineer in Government work when he recently retired after 53 years of continuous service. He was President of the St. Louis Section of the Society in 1921.

GEORGE M. BACON, State Engineer of Utah since 1925, was elected President of the Western Association of State Engineers at the annual meeting held recently in Sacramento, Calif.

HARRY BARTON, General Superintendent of the Pittsburgh Suburban Water Service Company, a division of the Federal Water Service Corporation, New York City, was previously General Manager of the New Jersey Water Service Company, Federal Water Service Corporation, in Little Falls, N.J.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From November 10 to December 9, 1931

Additions to Membership

ACKERSON, WARREN CROSSMAN (Jun. '31), 3604 Baring St., Philadelphia, Pa.

ADES, CLIFFORD SUMNER (Jun. '31), 46 Rosemary Drive, Rochester, N.Y.

ALPHER, ROBERT JEROME (Jun. '31), Asst. Structural Engr., Constr. Div., Office of Quartermaster Gen., War Dept. (Res., 3544 Hertford Pl., N.W.), Washington, D.C.

AULTMAN, WILLIAM WHITESCARVER (Jun. '31), Junior Hydr. Engr., Met. Water Dist. of Southern California, 306 West 3d St. (Res., 1610 North Normandie Ave.), Los Angeles, Calif.

BANNERMAN, ROBERT CHARLES, JR. (Jun. '31), with State Highway Comm., Box 167, Jonesville, La.

BARRIE, WILLIAM (Jun. '31), 23 Hancock Ave., Yonkers, N.Y.

BARTHOLET, CHARLES JOSEPH (M. '31), State Supervisor of Hydraulics, Dept. of Conservation and Development, 202 West 18th St., Olympia, Wash.

BECKER, ALBERT ANSTIN (Jun. '31), 629 Chestnut St., Columbia, Pa.

BERNSTEIN, SAUL (M. '31), Treas. and Managing Engr., Fredburn Constr. Corp., 60 East 42d St., New York, N.Y.

BISBORT, HAROLD EDWIN (Jun. '31), 2128 North 4th St., Philadelphia, Pa.

BOGART, JOHN ALLEYNE CALHOUN (Jun. '31), Box 315, Gainesville, Fla.

BOUTOURLINSKY, MICHARL PETROVITCH (Jun. '31), 4836 Summerdale Ave., Philadelphia, Pa.

BRADLEY, STEPHEN ROWE, JR. (Jun. '31), North Broadway, Nyack, N.Y.

BRAND, THEODORE (Jun. '31), 1065 Lafayette St., Denver, Colo.

BROWN, FRANKLIN STEWART (Jun. '31), Y.M.-C.A., Rock Island, Ill.

BROWN, RALPH CHARLES (Jun. '31), Draftsman, Cincinnati Union Terminal Co., Cincinnati, Ohio (Res., 25 East 3d St., Newport, Ky.).

BROYLES, JOHN SUMMERFIELD (Assoc. M. '31), Engr., United Gas Co., Box 1760, Houston, Tex.

BRUMLEY, DAVID JOSEPH (Jun. '31), 909 Bruce Ave., Flossmoor, Ill.

BURNETT, DOUGLAS HAROLD (Jun. '31), 3847 Twenty-first St., San Francisco, Calif.

BURROUGHS, WILLIAM EVERETT (Jun. '31), Tracer, Bureau of Bridges, State Dept. of Highways (Res., 1495 Michigan Ave.), Columbus, Ohio.

CAMPBELL, MORGAN SKILES (Jun. '31), care, U.S. Engr. Office, River at Burdette, St., New Orleans, La.

CANTONO, WILLIAM PAUL (Jun. '31), 1722 Cayuga St., Philadelphia, Pa.

CAREY, CLYDE CARLTON (M. '31), Supt. of Constr., Winston Bros. Co., 1470 North West Bank Bldg. (Res., 4916 South Upton Ave.), Minneapolis, Minn.

CARGILL, DANIEL OLNEY (Assoc. M. '31), Bridge Engr., State Board of Public Roads, R.D. 2, Box 96, Valley Falls, R.I.

CASS, RILEY TOWNE (Jun. '31), Univ. of Colorado, Boulder, Colo.

CHAPE, BRUNO (Jun. '31), 7 Miles St., Binghamton, N.Y.

CHASTAIN, WILLIAM EMMITT (Jun. '31), 2145 North Main St., Decatur, Ill.

CHEMIDLIN, JOHN PRINCE (Jun. '31), Asst. Engr., Westchester County San. Comm., 61 Lawton Ave., Hartsdale, N.Y.

COHEN, HARRY AARON (Jun. '31), 1267 Forty-sixth Ave., San Francisco, Calif.

CONNER, HARRY MCKEAN (Jun. '31), 3804 Greystone Ave., New York, N.Y.

COON, EMMETT JOHN (Jun. '31), Junior Topographic Engr., U.S. Geological Survey, Box 346, Sacramento, Calif.

DAVIS, LEONARD JOEL (Jun. '31), 317 West Springfield Rd., Springfield, Pa.

DAVIS, ROBERT OLIN (Jun. '31), care, U.S. Geological Survey, Washington, D.C.

DOLLARD, JOHN THORVALD (Assoc. M. '31), Structural Designer, Gibbs & Hill, New York (Res., 157 Saratoga Ave., Yonkers), N.Y.

DOMBART, WILBUR BRUCE (Jun. '31), 329 North Washington St., Evans City, Pa.

DUCKERING, CHARLES ELMHIRST (Jun. '31), 225 North 12th St., Montebello, Calif.

ELLIOTT, BEN ROBERT (Jun. '31), 401 Cedar St., Washington, Mo.

ERICKSON, JACOB (Jun. '31), Box 41, Goodyear, Ariz.

ERLANDZON, ANDERS HUGO (Assoc. M. '31), Constr. Engr., A. B. Billingsfors Longed, Billingsfors, Sweden.

FANNER, PERCIVAL ARTHUR (Assoc. M. '31), Estimating Engr., Industrial Brownhoist Corp., Cleveland (Res., 1517 Wayne Ave., Lakewood), Ohio.

FELIX, RICHARD KNOTWELL (Jun. '31), 308 Park Pl., Sault Ste. Marie, Mich.

FINKBINE, AMOS (Jun. '31), Senior Eng. Draftsman, U.S. Engrs., Flood Control Section (Res., 54 Glenwood Ave.), Cincinnati, Ohio.

FIRSHT, PETER (Jun. '31), 517 East Cabot St., Philadelphia, Pa.

FISH, JOSEPH THEODORE (Jun. '31), 27 Ford Ave., Oneonta, N.Y.

FOOTE, ARTHUR JAMES (Assoc. M. '31), Engr., 2 North Chatsworth Ave., Larchmont, N.Y.

FOX, JOSEPH ALBERT (Assoc. M. '31), Res. Engr., Public Structures, City Engrs' Office (Res., 1986 Atkinson Ave.), Detroit, Mich.

FRANZEN, EDWIN CHALMER (Jun. '31), Y.M.C.A. Bldg., Rock Island, Ill.

FRBIN, JOSEPH, JR. (Jun. '31), with St. Louis County Highway Dept., 3815 Forest Park Boulevard, St. Louis, Mo.

FUNK, LOUIS (Jun. '31), 550 Riverside Drive, Apt. 65, New York, N.Y.

GILIBERTY, FRANK RALPH (Jun. '31), 154 Howard Ave., New Haven, Conn.

GIONTI, ARTHUR, JR. (Jun. '31), Gionti Place and Venna Ave., North Haledon, N.J.

GOLDBERG, JOHN EDWARD (Jun. '31), 6530 South Sangamon St., Chicago, Ill.

GOVE, ALFRED WALLACE (Jun. '31), 6 Humboldt Ave., Worcester, Mass.

GREEN, JOHN NORVELL (Assoc. M. '31), Engr., McKenzie Constr. Co. and Uvalde Constr. Co., Box B, Bridgeport, Tex.

GREEN, STERLING STEFFEN (Jun. '31), 2283 West 27th St., Los Angeles, Calif.

GREENAWALT, WILLIAM PORTER (Assoc. M. '31), Railway Sales Mgr., Spokane Culvert & Tank Co. (Res., 4009 Fifteenth Ave., N.E.), Seattle, Wash.

GRIMES, HOWARD BECKER (Jun. '31), 29 East High St., Womelsdorf, Pa.

GROVER, WILLIAM EDWARD (Jun. '31), 2328 Lawrence Ave., Toledo, Ohio.

GULICK, HAROLD VAN DYKE (Assoc. M. '31), with Gannett, Seeley & Fleming, Harrisburg (Res., 515 West 16th St., New Cumberland), Pa.

HAILE, ELMER RATHBUN, JR. (Jun. '31), Reckord Bldg., Towson, Md.

HAMMERSMITH, ROBERT CHARLES (Jun. '31), 204 South Maple St., Sycamore, Ill.

HARTLOFF, MARVIN SHELDON (Jun. '31), Box N, Warwick, N.Y.

HARVEY, FOSTER WARREN (Assoc. M. '31), Designer, Bureau of Bridges, State Highway Dept., Box 560, Jefferson City, Mo.

HAWORTH, HAROLD LORENZ (Jun. '31), St. Joseph, Ill.

HEPWORTH, CLARE (Jun. '31), 1541 West McKinley, Phoenix, Ariz.

HESTER, JAMES TAYLOR (Jun. '31), 1460 Eighteenth Ave., San Francisco, Calif.

HEWETT, LOUIS FREEMAN (M. '31), Pres. and Chf. Engr., Fredburn Constr. Corp., New York (Res., 135 Broadview Ave., New Rochelle), N.Y.

HIMMELMAN, CARL CONRAD (Jun. '31), Topographical Draftsman, Board of Transportation, New York (Res., 86-35 Broadway, Elmhurst), N.Y.

HODGKINSON, NORMAN BATEMAN (Assoc. M. '31), Chf Designing Engr., Los Angeles County Flood Control Dist., Los Angeles (Res., 912 Summit Drive, South Pasadena), Calif.

HOFFMAN, GERALD HENRY (Jun. '31), Surveyman and Insp., U.S. Engrs., U.S. Engr. Office, Washington, Mo.

HOLLEN, EDWARD JAMES (M. '31), Executive Vice-Pres. and Mgr., Rowley Constr. Co., Pawtucket (Res., 16 Hazard Ave., Providence), R.I.

HOUCK, FRED ADAM (Jun. '31), U.S. Bureau of Reclamation, Customs House Bldg., Denver, Colo.

HUNTER, ARCHIBALD DANIEL (Jun. '31), Lieut. (j.g.) C.E.C., U.S.N., Apartment 64, Southcourt Apartments, Bremerton, Wash.

HUNTER, HARRY CLYDE (M. '31), Div. Erecting Mgr., Am. Bridge Co., 208 South La Salle St., Room 1396, Chicago, Ill.

HURST, ERNEST GERALD (Jun. '31), 814 Langdon Ave., Alton, Ill.

IRONS, CHARLES WILLIAM (Jun. '31), Linesville, Pa.

JACKSON, SHERMAN KEITH (Jun. '31), Junior Hydr. Engr., U.S. Geological Survey (Res., 2065 Park Rd.), Washington, D.C.

JOHNSON, ARTHUR ALVIN (Assoc. M. '31), Asst. Supt., The Solvay Process Co., Box 117, Moline, Kans.

JOHNSON, ELDON ALFRED (Jun. '31), 837 East 86th St., Chicago, Ill.

JONES, CLIFFORD CROWE (Jun. '31), 107 Mulberry St., Greenville, S.C.

JOUBERT, EMILIO GUAROA (Assoc. M. '31), Compañia Agricola Dominicana, Santiago, Dominican Republic.

KELLEY, CHARLES CLARENCE (M. '31), Cons. Civ. Engr., 119 South 5th St., Klamath Falls, Ore.

KINNEY, JOSEPH STERLING (Jun. '31), 2213 Twelfth St., Troy, N.Y.

KISWALTER, GEORGE, JR. (Jun. '31), 76 Seaman Ave., New York, N.Y.

KLAHRE, ALFRED CHARLES, JR. (Jun. '31), Asst. to W. Knospe (Res., 922 Albemarle Rd.), Brooklyn, N.Y.

KLEINSCHMIDT, ROBERT BAUMGARTNER (Jun. '31), 3224 North Carlisle St., Philadelphia, Pa.

KOFFMAN, LOUIS ANDREW (Jun. '31), 2415 North Patton St., Philadelphia, Pa.

KOTTA, RAY JOSEPH (Jun. '31), 873 Broadway, San Francisco, Calif.

KROTT, CARL HARRY HERBERT (Jun. '31), 326 South 10th St., Reading, Pa.

LANGSNER, GEORGE (Jun. '31), Chairman, State Div. of Highways, 709 North Soto St., Los Angeles, Calif.

LAUTERBACH, RITTNER ANDREW (Jun. '31), Laboratory Asst.-Physical Testing Engr., Bowser-Morner Testing Laboratory (Res., 3115 Wayne Ave.), Dayton, Ohio.

LEONARD, CLARE MORTIMER (Jun. '31), 949 East 28th St., Brooklyn, N.Y.

LINK, ROBERT EMMETT (M. '31), Gen. Supt. of Constr., New York Steam Corp., 280 Madison Ave., New York, N.Y.

LIPPINCOTT, JOSHUA GORDON (Jun. '31), 2 Crane Ave., White Plains, N.Y.

MAC MURRAY, PAUL (Jun. '31), 4510 Chestnut St., Apartment 307, Philadelphia, Pa.

MCATEE, FRAYNE LEIGH (Jun. '31), care, State Bureau of Highways, Boise, Idaho.

MCINTYRE, JOHN CHANDLER (Jun. '31), 1643 Ellis Boulevard, Cedar Rapids, Iowa.

MADISON, KNOWLES KNOWLTON (Jun. '31), 757 Covington Drive, Detroit, Mich.

METCALFE, HENRY MOORE (Jun. '31), Wapello, Iowa.

MIDDLEBROOKS, THOMAS ALWYN (Jun. '31), Insp. of Levees, U.S. Engr. Office, Vicksburg, Miss.

MILNAMOW, ARTHUR (Jun. '31), 1101 Linwood Ave., Collingswood, N.J.

MORGAN, AUSTIN (Jun. '31), Field Engr., Phillips Petroleum Co., Bartlesville, Okla.

MULLIN, HOWARD LEON (Jun. '31), Junior Engr., Civil Service Comm., Mississippi River Flood Control, care, U.S. Engr. Office, Lake Providence, La.

MUSACCHIO, THOMAS VITO (Jun. '31), 197 Grant Ave., Brooklyn, N.Y.

NORFORD, VIRGIL HAROLD (Jun. '31), 5864 North Broadway, Indianapolis, Ind.

NORRIS, CHARLES HEAD (Jun. '31), 21 Falmouth St., Belmont, Mass.

OLMAN, SAMUEL (Jun. '31), Asst. Res. Engr., State Bridge Dept. (Res., 4621 South Normandie Ave.), Los Angeles, Calif.

PACKARD, DANIEL BERRY, JR. (Jun. '31), with Atlantic Coast Line R. R., 119 Nunn St., Wilmington, N.C.

PAQUETTE, JOSEPH ALBERT (Assoc. M. '31), 199 Crescent St., Peterboro, Ont., Canada.

PAUL, CHARLES GEORGE (Jun. '31), 133 Nelson St., Syracuse, N.Y.

PEARCE, FRED OWEN (Assoc. M. '31), Chf. Engr. and Estimator K. E. Parker Co., San Francisco (Res., 5880 Chabot Court, Oakland), Calif.

PENHUNE, PAUL (Assoc. M. '31), Bridge Designer and Superv. Draftsman, P.R.R., Room 351, Pennsylvania Station, New York, N.Y.

PFEFFER, CHARLES RING (Jun. '31), 309 Broxton Rd., Baltimore, Md.

PIERLEONI, CARL (Assoc. M. '31), Vice-Pres. Clemente Contr. Co., Inc., 749 Coster St., New York, N.Y.

POLI, THOMAS (Jun. '31), Junior Asst. Civ. Engr., Grade 1 (Field), State Dept. of Public Works, Div. of Highways, 56 West 106th St., New York, N.Y.

PORE, FRANK WALDO (Assoc. M. '31), Deputy County Surv., Los Angeles County, 500 Klinker Bldg. Los Angeles, Calif.

POTTS, CHARLES EDWARD, JR. (Jun. '31), 69 Church St., West Haven, Conn.

PRESTINI, VERO ERNEST (Jun. '31), 131 Granite St., Westerly, R.I.

RASMUSSON, IRVIN SHERMAN (Assoc. M. '31), Surv. and Junior Engr., Section of Surveys, Panama Canal, Balboa Heights, Canal Zone.

REY, RICHARD FRANKLIN (Assoc. M. '31), City Structural Engr., City Eng Dept. (Res., 724 West Ionia St.), Lansing, Mich.

RICHARDSON, CHARLES ALLEN (Jun. '31), 224 Chestnut St., Haddonfield, N.J.

RINNE, JOHN ELMER (Jun. '31), with H. D. Dewell, San Francisco (Res., 1316 Albina Ave., Berkeley), Calif.

RITCHIE, OSCAR THOMAS (Jun. '31), 3124 North 27th St., Tacoma, Wash.

ROMINIECKI, ANDREW JOSEPH (Jun. '31), Engr., Vacuum Oil Co., Paulsboro, N.J. (Res., 4498 Livingstone St., Philadelphia, Pa.)

RYAN, JOHN HENRY (Assoc. M. '31), Prin. Asst. to Constr. Engr., Eng. Dept., City of San Francisco, care, Hetch Hetchy Water Supply, Livermore, Calif.

SANDERS, WALLACE WOLFRED (Assoc. M. '31), Asst. Dist. Engr., State Highway Dept. (Res., 2635 Virginia Ave.), Louisville, Ky.

SAVARESE, LOUIS BERNARD (Jun. '31), 63 Perry St., New York, N.Y.

SHELLARD, GORDON DURYEA (Jun. '31), 420 Mountain Ave., Ridgewood, N.J.

SIEKIELSKI, GEORGE STANLEY (Jun. '31), Insp. with Clyde Potts (Res., 175 Overlook Ave.), Boonton, N.J.

SMOUSE, JOHN PAUL (Jun. '31), 2115 St. Joseph Ave., St. Joseph, Mo.

SNOW, EDWIN JAMES (Jun. '31), 764 South Kilbourn Ave., Chicago, Ill.

SOBIERALSKI, VALENTINE RALPH (Jun. '31), 5 Harvard Pl., Baldwin, N.Y.

SOEHRENS JOHN EULER (Jun. '31), Room 509, Y.M.C.A., 16th and Lincoln, Denver, Colo.

SOLOMON, MORTON (Jun. '31), 253 Old Mamaroneck Rd., White Plains, N.Y.

SORENSEN, CARL HEINRICH (Assoc. M. '31), Engr. in Chg. of Design, The Leake & Nelson Co. (Res., 144 Lenox Ave.), Bridgeport, Conn.

SOUSLEY, EARL EMANUEL (Assoc. M. '31), Res. Engr. for County Engr. (Res., 308 Monmouth Ave.), Lakewood, N.J.

STAUDER, ARTHUR OSCAR (Assoc. M. '31), Engr. in Chg. of Constr., Board of Local Impvts. (Res., 6449 North Seeley Ave.), Chicago, Ill.

STELGER, JOHN ALBERT (Jun. '31), 551 Valley Rd., West Orange, N.J.

STIVERS, EARL RAIMON (Assoc. M. '31), Research Engr., Package Research Laboratory (Res., 17 Halsey Ave.), Rockaway, N.J.

STOCKER, FRANK RAYMOND (Jun. '31), Engr., Edeburn, Cooper & Co., 2103 Law & Finance Bldg., Pittsburgh (Res., 1234 Vance Ave., Coraopolis), Pa.

STREETER, VICTOR LYLE (Jun. '31), Marcellus, Mich.

STUBBS, JAMES ARMSTRONG (Jun. '31), 2343 Ninth St., Boulder, Colo.

SYMNS, SAMUEL YOUNG, JR. (Jun. '31, Recorder, U.S. Coast and Geodetic Survey, Washington, D.C.

SYREWICZ, FRANCIS JOSEPH (Jun. '31), 2733 Orthodox St., Philadelphia, Pa.

THOMAS, DAN HORACE (Assoc. M. '31), Supt., National Cement Pipe Co., 1428 North Broadway, Santa Ana, Calif.

TORRAS, RAYMOND WILLIAM (Assoc. M. '31), Engr. and Sec'y, City Planning Comm., 308 City Hall, Atlanta, Ga.

VOLDRICH, CONSTANTINE BRZOBOHATY (Jun. '31), 4465 Murray Ave., Shorewood, Milwaukee, Wis.

VOSS, CLAYTON HENRY (Jun. '31), 59 Jasper St., Houghton, Mich.

WAGNER, LAWRENCE FREDRICK (Jun. '31), 1934 Bridge St., Philadelphia, Pa.

WALLACE, GORDON (Jun. '31). Eng. Draftsman, N.Y.C.R.R., Terminal Dist. Engrs.' Office (Res., 650 West 177th St.), New York, N.Y.

WEINKAUFF, HENRY CHRISTIAN CORNELIUS (Jun. '31), 7740 Seventy-ninth Pl., Glendale, N.Y.

WEIR, DONALD ARTHUR (Jun. '31), Route 3, Ashtabula, Ohio.

WELLS, HEBER (Jun. '31), 25 Fairview Terrace, Malden, Mass.

WERNER, ARTHUR VINCENT (Jun. '31), with U.S. Dept. of Interior, Bureau of Reclamation, Custom House (Res., 1140 Pennsylvania St.), Denver, Colo.

WERNER, PAUL EVERETT (Jun. '31), 617 Elm St., Moscow, Idaho.

WHITCOMBE, FRANCIS HENRY (Jun. '31), 55 Bowdoin St., Newton Highlands, Mass.

WHITE, SARGENT (Jun. '31), Route 2, Alexandria, Va.

WILSON, JOHN (M. '31), City Engr., (Res., 702 North 19th Ave., East), Duluth, Minn.

WIRE, CHARLES RAYMOND (Assoc. M. '31), (Wire Constr. Co., Inc.), 3521 Rittenhouse St., N.W., Washington, D.C.

WOOD, BENSON JARVIS (Jun. '31), 1816 Gratiot Ave., Saginaw, Mich.

WOOD, GEORGE MCCAW (Jun. '31), 127 South Wood St., Maroa, Ill.

WRIGHT, GRAYDON CLIFTON (Jun. '31), Junior Engr., U.S. Bureau of Reclamation, Custom House Bldg., Denver, Colo.

ZAHORIK, PETER ANTON (Assoc. M. '31), with Kalman Steel Co. (Res., 312 East Wisconsin St.), Milwaukee Wis.

MEMBERSHIP TRANSFERS

BERTWELL, WILLIAM (Jun. '26; Assoc. M. '31), Chf. Draftsman, Bridge Dept., State Highway Comm. (Res., 14 Eybel Hotel), Helena, Mont.

BURT, EARLE ANDREWS (Jun. '18; Assoc. M. '22; M. '31), Constr. Engr., Los Angeles County Road Dept., 1104 Hall of Records, Los Angeles (Res., 1147 East Mendocino St., Altadena), Calif.

CRIST, MARION LOWELL (Jun. '27; Assoc. M. '31), Associate Engr., Burns-McDonnell-Smith Eng. Co., 455 Western Pacific Bldg., Los Angeles, Calif.

GERHART, ROBERT WHITFIELD (Jun. '26; Assoc. M. '31), Production Dept. Engr., Consolidated Steel Corp., Ltd., 1200 North Main St., Los Angeles, Calif.

HOBBS, HAROLD WAYNE (Jun. '26; Assoc. M. '31), Res. Engr., Glenn D. Holmes, Marcellus (Res., 328 Ellis St.), Syracuse, N.Y.

HOYT, WILLIAM GLENN (Assoc. M. '13; M. '31), Hydr. Engr. (Prin.) Conservation Branch, U.S. Geological Survey, Washington, D.C.

JONES, KIRBY VIGLINI (Assoc. M. '22; M. '31), Res. Engr., Phoenix Utility Co., Carpenter Dam, Hot Springs, Ark.

PHILLIPS, JAMES EMERSON (Assoc. M. '25, M. '31), Engr., Owens River Aqueduct Div., Dept. of Water and Power, 207 South Broadway, Los Angeles, Calif.

RIBAL, RAYMOND ROBERT (Jun. '28; Assoc. M. '31), Office Engr., City of Oakland, Room 701, City Hall, Oakland, Calif.

RESIGNATIONS

ALLARDICE, JAMES PROCTOR, Assoc. M., resigned Dec. 1, '31.

BLAND, RICHARD LOUIS, Assoc. M., resigned Nov. 11, '31.

BUSFIELD, JAMES LEONARD, M., resigned Dec. 8, '31.

DAVIS, EDSON JOSEPH, Assoc. M., resigned Nov. 7, '31.

FLORANCE, EDWIN, Assoc. M., resigned Nov. 10, '31.

GIALDINI, GENE JOHN, Jun., resigned Dec. 7, '31.

HARTMAN, HARRY FRANKLIN, Jun., resigned Nov. 7, '31.

JAMISON, GEORGE HOLT, Assoc. M., resigned Dec. 2, '31.

JIRANEK, LEO AUGUST, Jun., resigned Dec. 7, '31.

KENT, CHARLES NELSON, M., resigned Dec. 2, '31.

MACDONALD, FREDERICK ALEXANDER, M., resigned Nov. 20, '31.

MAIGNEN, JEAN PROSPER AUGUSTE, Affiliate, resigned Nov. 28, '31.

WALMSLEY, WALTER NEWBOLD, M., resigned Dec. 8, '31.

WANG, KUEI HSUN, Assoc. M., resigned Dec. 5, '31.

DEATHS

ADAMS, RAYMOND EDMOND. Elected Jun., May 1, 1900, Assoc. M., Dec. 6, 1905, M., May 28, 1912; died Dec. 1, 1931.

BAILHACHE, JOHN GOODIN. Elected Jun., Mar. 4, 1914, Assoc. M., Oct. 14, 1919, M., Jan. 16, 1928; died Nov. 9, 1931.

BAIRD, SAMUEL POND. Elected Assoc. M., Mar. 1, 1899, M., Sept. 4, 1906; died Nov. 26, 1931.

BENSON, NEWTON DAVIS. Elected Assoc. M., July 10, 1907; died Nov. 18, 1931.

BRINCKERHOFF, ALEXANDER GORDON. Elected M., Nov. 3, 1886; died Sept. 4, 1931.

CALLERI, ARMAND JOHN. Elected Assoc. M., Mar. 5, 1928; date of death unknown.

HOOPES, EDGAR MALIN, JR. Elected Assoc. M., Apr. 17, 1917; died Nov. 20, 1931.

JANES, GEORGE PORTLOCK. Elected M., May, 1907; died Nov. 13, 1931.

SOWDEN, HERBERT JONES. Elected Assoc. M., Oct. 10, 1927; died Nov. 14, 1931.

STERN, EUGENE WASHINGTON. Elected M., Mar. 3, 1897, died Nov. 9, 1931.

SYMONDS, HENRY ALLEN. Elected M., Oct. 1, 1926; died Feb. 17, 1931.

WORTHINGTON, CHARLES. Elected Assoc. M., Dec. 1, 1897, M., Nov. 6, 1901; died Aug. 29, 1931.

TOTAL MEMBERSHIP AS OF DECEMBER 9, 1931

Members	5,901
Associate Members	6,358
Corporate Members	12,259
Honorary Members	18
Juniors	2,816
Affiliates	126
Fellows	5
Total	15,224

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

HYDRAULIC CIVIL ENGINEER; M. Am. Soc. C.E.; 37; married; university graduate; 15 years experience all phases hydro-electric development—design, construction, preliminary studies. Fully qualified by experience to plan from cost standpoint, domestic and foreign locations, all types of dams and structures; also estimates and reports, and large projects. Available immediately. C-9694.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 35; 6 years experience large bridge construction; 2½ years general building and power plant construction; 2½ years railroad construction. Desires connection with construction firm in field as engineer, superintendent, or foreman. Location immaterial. B-4497.

BRIDGE ENGINEER; M. Am. Soc. C.E.; American; married; 5 years as office engineer in charge of design of bridges, viaducts, foundations, and subways; 15 months on tunnel design; 12 years on design, detail, and checking bridge and structural work; 4 years experience with movable bridge machinery. Desires responsible position as office engineer—design or supervision. D-81.

EXECUTIVE, CONSTRUCTION, AND MAINTENANCE ENGINEER AND SUPERINTENDENT; M. Am. Soc. C.E.; married; 7 years experience on maintenance of way; 3 years as chief engineer on electric railroads; 3 years on reconstruction of steam railroad terminal yards, piers, and general waterfront work; 3 years on valuation and appraisal of public utilities. Desires permanent connection. Any location. B-1686.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; 3½ years experience in building construction as engineer and superintendent of apartment houses, theaters, and office buildings with large metropolitan construction company; 1 year as field engineer with New York excavator. Metropolitan location preferred. C-3233.

STRUCTURAL AND MECHANICAL ENGINEER; Assoc. M. Am. Soc. C.E.; 10 years experience in designing both mechanical and structural work. Experience covers refining plants, mill buildings, concrete mixers, scales, hoists, plant maintenance, and foundations. Good knowledge of pattern making, molding, and machine shop practice. Available as designer, draftsman, shop superintendent, or foreman. C-8644.

CIVIL ENGINEER; Jun, Am. Soc. C.E.; graduate, Rensselaer Polytechnic Institute, 1931; desires opportunity in construction, sanitary engineering, or surveying. Knowledge of Italian and Spanish. Available immediately. Location immaterial. C-9828.

HYDRAULIC AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate, 1913; with A.E.F. engineers; past 8 years with consulting engineers on surveys, design and construction of hydro-electric, steam, and water supply projects, and reports and estimates. Similar work desired with opportunity for advancement. D-113.

CIVIL AND HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; married; graduate, civil engineering college; concrete designer and checker. Long experience in hydro-electric field, earth dams, hydraulic structures, and foundations. Designer of many hydro-electric plants. Now available at reasonable salary. United States preferred. D-108.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; graduate, Worcester Polytechnic Institute. Design and supervision of industrial buildings and movable, long-span, and railroad bridges. Special work on secondary stresses in bridges. Five years in responsible positions—design and construction. D-111.

PAPER MILL DESIGNER AND DRAFTSMAN; Assoc. M. Am. Soc. C.E.; 33; married; graduate civil engineer; 8 years experience in design and construction of pulp and paper mills (including complete equipment and piping layouts), steel, concrete, and timber structures. Naturalized; speaks Russian. Available now. Location anywhere, but Pacific Coast preferred. D-119.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; B.S. in C.E. and M.S. in M. and S.E.; 5 years with official departments of health; 4 years with consulting engineers on water supply, water purification, sewerage, and sewage treatment projects. Available on short notice. B-8539.—3674—Chicago.

CIVIL ENGINEER AND EXECUTIVE; M. Am. Soc. C.E.; married; graduate, Cornell; 20 years experience as general contractor in Latin America—particularly in building construction, sewer, water supply, and irrigation works, docks, and real estate developments; investigations, estimates, and reports. Desires connection with responsible firm engaged in engineering, contracting, or commercial enterprises in Spanish-speaking countries. D-100.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; unmarried; 20 years experience designing and supervising construction, water-works, sewer, and paving projects; city and town-site planning and development; drainage and railroad work. Reciprocal registration certificate, National Council State Board of Engineering Examiners. Available at once. Location domestic or foreign. D-123.

ENGINEERING AND SALES EXECUTIVE; M. Am. Soc. C.E.; technical graduate; varied engineering and sales experience in United States and foreign countries. Good knowledge of Spanish. Located in United States for past 15 years as district manager for engineering and contracting firm of international reputation. Will meet responsible representative in New York City. C-9631.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; Yale graduate; desires position in the metropolitan district. Has had five years of experience with well known firm of industrial engineers and builders, in construction, design, and estimating. D-53.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; graduate, University of Missouri; 5 years experience as consulting engineer in charge of construction, design, location, sewers, and paving; 2 years railroad experience on construction and maintenance for large Middle-western line. Location immaterial. Available at once. C-8325.

ENGINEER EXECUTIVE; Assoc. M. Am. Soc. C.E.; 33; married; graduate engineer; 10 years experience, including production, machine and construction design, specifications, consulting work, construction, estimating, bidding, sales, and procurement. At present assistant treasurer and superintendent of operations for construction company. B-5822.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; experienced railroad maintenance, electric transmission-line design, structural design, and construction of underwater foundation. Desires connection with consulting engineer or contractor. Available at once. Location, Pacific Coast. D-154.—3111-A-8—San Francisco.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 23; graduate, Pennsylvania State College School of Engineering, 1931; willing to work; desires opportunity with structural engineer or architect; 7 months building construction experience. Available immediately. Location United States or Canada. D-141.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; B.S. in C.E., Rice Institute, 1930; 4 years pipe-line engineering; 9 months municipal development and executive experience. D-160.

CONSTRUCTION ENGINEER AND SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; 30; single; 6 years varied experience on hydro-electric plants, bridges, roads, and industrial buildings; 1½ years responsible charge of development in West Africa; past 2 years in charge of extensive building operations, involving real estate negotiations, contracts, specifications, and payments. Location immaterial. D-142.

CIVIL ENGINEER; M. Am. Soc. C.E.; 20 years continuous experience on important engineering projects, including flood prevention, highway and railroad location and construction, grade separation, track elevation, and retarder yards. Extensive office experience covering drafting, design, estimating, and reports. Will consider moderate starting salary. B-9037.

CIVIL AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; graduate; California license; 8 years experience design, detail, investigations, estimates, and specifications of, and for, timber, structural steel, and reinforced concrete structures, highway bridges, viaducts, hydraulic structures, arches, and rigid frames. Available immediately. Location Pacific Coast or Middle West. D-155.

JUNIOR CIVIL ENGINEER; 21; recent graduate of engineering school of good standing; willing and intelligent worker. Personal interviews desired. D-152.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience, design and construction, estimates, inspection, and surveys, including railroads, subways, buildings, and bridges. Capacity to assume responsibility. Desires connection with construction company, consultant, contractor, or architect, preferably in field engineering construction or related work, sales engineering, or instructorship. C-2605.

STRUCTURAL AND SALES ENGINEER; Assoc. M. Soc. C.E.; 38, married; 12 years experience in sales and sales management, design, detail, and estimating of all steel requirements for bridges and buildings. Available immediately. Capable and forceful. University graduate. Location immaterial. D-16.

CIVIL AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate; 20 years experience in design and construction; housing groups for private interests and state institutions, including sewers, water supply, and all utilities; industrial plants; hydro-electric developments. Experience covers supervision of entire work, including preliminary studies, estimates, and architectural and mechanical work. B-2835.

CONSULTING AND CONSTRUCTING ENGINEER; M. Am. Soc. C.E.; over 30 years experience going into Latin-American and Far Eastern countries, opening them up, and building water supplies, hydro-electric installations, and power plants with railroad and harbor developments. Available immediately, for countries of recent change of government, to report on concessions and existing installations and their operation, as well as for new work. A-5380.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; recent graduate; desires opportunity for obtaining experience; salary secondary. Available immediately. D-156.

PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; American-born; Presbyterian; Ph.B., B.S., M.S., and C.E.; open for position teaching civil engineering courses other than sanitary—preferably mechanics, structures, or highways; 20 years technical and administrative engineering experience; 4 years teaching. Qualified personally. B-5954.

ASSISTANT ENGINEER AND DRAFTSMAN; Jun. Am. Soc. C.E.; 31; civil engineering graduate, University of Pittsburgh, 1928. Subway and railroad layouts; design of grades; surveying; topographical drafting; estimating; engineering calculations. Technical interpretation—English-Russian, Russian-English. D-166.

STRUCTURAL AND SALES ENGINEER; M. Am. Soc. C.E.; 44; married; over 15 years experience directing, estimating, designing, pricing, and sale of structural steel fabricating business in western Pennsylvania and Ohio districts. Desires connection with progressive concern. Available immediately. C-5095.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

BRITISH COLUMBIA. Suspension Highway Bridge in British Columbia, P. Philip. *Contract Rec.*, vol. 45, no. 43, Oct. 28, 1931, pp. 1285–1287, 5 figs. Design and construction of suspension bridge having a main span of 460 ft., 250 ft. above low water; floor of laminated cedar with brush coat of hot asphalt; pre-stretching of wire ropes on site.

COFFERDAMS, GROUTING. Sealing Bridge Cofferdams by Grouting, E. O. Goldstein. *Eng. News-Rec.*, vol. 107, no. 16, Oct. 15, 1931, p. 610, 2 figs. Grout injection successfully sealed ledge covering of gravel and boulders, through which steel sheeting could not be driven, in building piers of new highway bridge across the Arkansas River at Ozark, Ark.

CONCRETE ARCH. Reconstruction of Locust Street Bridge, J. M. Tippee. *Iowa Eng. Soc.*, vol. 6, no. 4, Oct. 1931, pp. 74–82, 4 figs. Report on thorough repair of 5-span reinforced-concrete arch bridge 502 ft. long and 66 ft. wide between handrails; built in 1909.

CONCRETE FRAME. Rigid Frame Design as Applied to Bridge Construction, A. G. Hayden. *Engrs. and Eng.*, vol. 48, no. 10, Oct. 1931, pp. 228–236, 21 figs. Review of principles of design and results of tests, with special reference to the practice of the Westchester County Park Commission of New York.

HUDSON RIVER, N.Y. Bridging the Hudson at Fort Lee. *Eng. News-Rec.*, vol. 107, no. 17, Oct. 22, 1931, pp. 640–645, 10 figs. General review of engineering design, controlling conditions, and main elements of 3,500-ft. suspension crossing; basic site-selection factors; cables and suspension system; floor and bracing; towers.

MOVABLE, BOSTON. Rare Old Bridges Replaced in B. &. M. Railroad Terminal Improvements at Boston. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, pp. 718–722, 7 figs. Six jackknife-type structures dating back to 1835 give way to 4 single-leaf bascules; 65 acres of trestlework removed; construction and track changes carried on under heavy train traffic; filling and channel changes; design of new bridges; track changes and schedules.

OREGON. St. Johns Bridge at Portland Ore., M. E. Reed. *West. Construction News*, vol. 6, no. 19, Oct. 10, 1931, pp. 517–520, 7 figs. Construction of suspension bridge having the highest long span in the world, 205 ft. above water and 1,207 ft. long; bridge was constructed with twisted-strand cables; description of the roadway and sidewalks.

PLATE GIRDER. Long Highway Plate-Girder Bridge Span, F. W. Skinner. *Can. Engr.*, vol. 61, no. 17, Oct. 27, 1931, pp. 19–20, 3 figs. Design and construction of highway plate-girder bridge of 154-ft. span about 66 ft. wide.

SUSPENSION, HUDSON RIVER. Cables of Hudson River Bridge, C. H. Barth, Jr. *Military Engr.*, vol. 23, no. 131, Sept.–Oct. 1931, pp. 451–455, 8 figs. General information on bridge with more detailed data on making of cables, their erection and anchoring.

VIADUCTS, CONCRETE, CONSTRUCTION. Unusual Forming Methods Employed on Los Angeles Viaduct, R. Youmans. *Concrete*, vol. 39, no. 5, Nov. 1931, pp. 7–9, 4 figs. Construction practice on viaduct 3,200 ft. long; appearance of the exposed concrete stressed; form work fabricated and assembled in units.

BUILDINGS

CONSTRUCTION. Modernized Material-Handling Methods Facilitate Construction of 20-Story Building. *Construction Methods*, vol. 13, no. 11, Nov. 1931, pp. 38–42, 14 figs. Method of construction of the Mutual Home and Savings Ass'n Building in Dayton, Ohio; concrete foundation mat; steel erection; rubbish disposal; plan of construction plant layout; concrete control.

FRAMED STRUCTURES, RIGID. Rigid Frames as Applied to Building Construction, C. T. Morris. *Engrs. and Eng.*, vol. 48, no. 10, Oct. 1931, pp. 237–240, 9 figs. Review of literature and outline of the method developed by H. Cross; comparison of results obtained by rigid mathematical analysis with those by the Cross method.

UNDERPINNING. Supporting Buildings Along the Nassau-Broad Street Subway, New York, N. Y., W. T. McIntosh. *Eng. and Contracting*, vol. 70, no. 11, Nov. 1931, pp. 289–293, 4 figs. Recapitulation of and supplementary information to article previously indexed from *Eng. News-Rec.*, July 2, 1931.

WIND BRACING. Current Researches on Steel Floors and Wind Design of Tall Buildings, F. H. Frankland. *Eng. News-Rec.*, vol. 107, no. 20, Nov. 12, 1931, pp. 777–778, 1 fig. Empire State wind-test installation of 32 strain gages on 8-tower columns at twenty-third floor, consisting of $\frac{1}{2}$-in. steel bars 50 in. long; comparison of fire-test results on battledeck floor; load tests of battledeck floor. Before Am. Inst. Steel Construction.

CONCRETE

AGGREGATES. Modern Concrete. *Engineer*, vol. 152, no. 3955, Oct. 30, 1931, p. 462. It is claimed that clean aggregate will make better concrete than semi-clean without increasing cost; strength of concrete is matter to be considered, not proportioning.

BOND STRENGTH. Bond Between Concrete and Structural Steel, J. A. Stevenson and H. E. Glenn. *Clemson Agric. College South Carolina—Eng. Experiment Station—Bul.*, no. 1, June 1931, 16 pp., 8 figs. Report on series of tests to find out bond strength existing between piece of flat steel and surrounding concrete when steel is embedded in concrete; adhesive bond and friction bond; results of tests made on shrinkage of concrete; adhesive bond between flat rolled steel and concrete is around 50 lb. per sq. in.; coefficient of friction between concrete and steel is around 0.7; internal pressure on steel embedded in concrete normal to steel surface appears to be 500 to 800 lb. per sq. in.

BUNKERS, DESIGN. Shallow Trough Bunkers, W. S. Gray. *Concrete and Constr. Eng.*, vol. 26, no. 10, Oct. 1931, pp. 578–586, 12 figs. Principles of design of reinforced concrete bunkers by which side and partition walls may be considered to act as very deep beams, and trough as thin flexible concrete structure in which steel takes most of load directly by tension to side walls; bottom may be either two-sided with discharge openings in one sloping face, or have three sides, one of which is horizontal and only sufficiently long to accommodate horizontal gates; mathematical discussion and numerical examples.

COLD-WEATHER CONSTRUCTION. Concreting in Cold Weather, W. E. Hart. *Contract Rec.*, vol. 45, no. 45, Nov. 11, 1931, pp. 1335–1338, 5 figs. General principles of cold-weather concreting; practical rules for cold-weather work; circulation of heat; steam heating; heating aggregates.

COLUMNS TESTING. Results of Reinforced Concrete Column Investigation at Lehigh University, W. A. Slater. *Engrs. and Eng.*, vol. 48, no. 10, Oct. 1931, pp. 219–227 and (discussion) 227–228, 16 figs. Historical review of concrete column testing; results of original tests of series of columns 8 in. in diam. and 5 ft. long, including long-time loading tests; stress-strain diagrams; division of load between concrete and reinforcement; effect of duration of test on stresses in steel and concrete.

CONTROL. Constant Consistency as an Aid to Concrete Control, T. C. Powers. *Eng. News-Rec.*, vol. 107, no. 18, Oct. 29, 1931, p. 704, 1 fig. Discussion by G. A. Smith, of article previously indexed from issue of Sept. 3, 1931.

CURING. Tentative Specifications for Curing Portland Cement Concrete Slabs with Bituminous Coverings (C81-31T). *Am. Soc. Testing Matls.—Tentative Standards*, 1931, pp. 246–247.

Tentative Specifications for Curing Portland Cement Concrete Slabs by Surface Application of Calcium Chloride (C83-31T). *Am. Soc. Testing Matls.—Tentative Standards*, 1931, p. 249.

DESIGN. Cutting Corners in Concrete Structural Design—III, J. R. Goetz. *Concrete*, vol. 39, no. 5, Nov. 1931, pp. 23–25, 3 figs. Bending moments in continuous beams with various loads solved by use of formulas and chart; partial and discontinuous loadings on continuous beams.

FRAMES, DESIGN. The Modified Slope-Deflection Equations, L. T. Evans. *Am. Concrete Inst.—Journal*, vol. 3, no. 2, Oct. 1931, pp. 109–130, 27 figs. Theoretical mathematical discussion developing application of slope-deflection equations to frames composed of members of variable moment of inertia; in solution of frame for moments, no distinction is made between girders and columns.

INDUSTRIAL PLANTS. Problem of Industrial Plant Floor, R. T. Elworthy. *Can. Chem. and Met.*, vol. 14, no. 10, Oct. 1931, pp. 277–278, 2 figs. New material manufactured in Canada; prodorite is new type of concrete in which specially prepared organic binder is employed in place of portland cement to bond together carefully selected and graded aggregate consisting of quartz or other acid-resistant stone; physical and chemical properties.

MIXING. Investigations in the Porportioning of Concrete for Highways, A. T. Goldbeck. *Nat. Crushed Stone Ass'n—Bul.*, no. 7, Sept. 1931, 56 pp., 17 figs. Results of investigations made to develop method for design of concrete having any desired modulus of rupture; method requires testing of preliminary trial batch of concrete containing aggregates to be used on work; from this trial batch, correct water-ratio for desired beam strength is obtained; finally second trial batch having corrected water-ratio is made up for determination of necessary batch weights.

RESERVOIRS, DETROIT, MICH. Unusual Features in Design and Construction of a 20-Million Gallon Concrete Reservoir, A. B. Morrill. *Am. Concrete Inst.—Journal*, vol. 3, no. 2, Oct. 1931, pp. 81–95, 7 figs. Report on construction of unit of Springwells water purification plant of City of Detroit water works; reservoir, having effective depth of 20 ft., is almost entirely underground; its roof is covered with 2 ft. of gravel and earth and carries roadways and walks; quantities and prices bid for Springwells reservoir construction; pile foundations; "swellage" due to pile driving; concrete design and mixtures; load test of roof slab; leakage test; waterproofing and surface drainage.

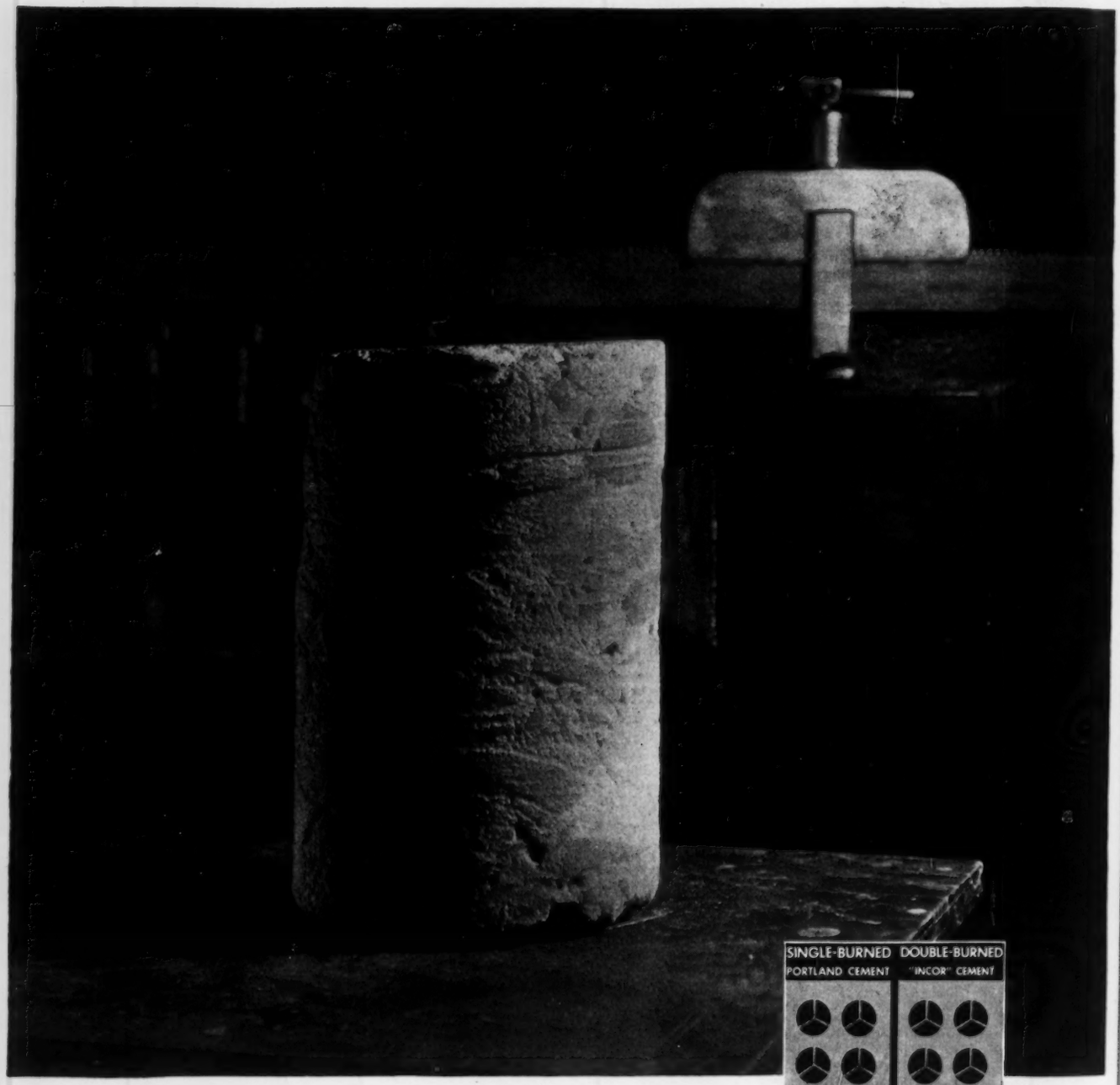
RUST REMOVAL. Removing Rust from Reinforcing Bars, W. S. Thomson and W. F. Zabriski. *Am. Concrete Inst.—Journal*, vol. 3, no. 3, Nov. 1931, pp. 13–14. Rust removal by hand and power brushing, also by passing bars through gas-fired furnace.

TESTING. Durability Tests of Cement Concrete, H. F. Clemmer. *Can. Engr.*, vol. 61, no. 16, Oct. 20, 1931, pp. 13–14 and 51. Causes of corrosion; use of vibrators; effect of freezing and thawing; acceleration of setting time. Before Can. Good Roads Ass'n.

WATER-CEMENT RATIO. Cement-Water Ratio by Weight Proposed for Designing Concrete Mixes, I. Lyse. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, pp. 723–724, 2 figs. Water-cement-ratio strength expressed by logarithmic curve; new relationship is nearly straight line; cement-water ratio is simpler expression of quality of cement paste than water-cement ratio; strength of concrete at different ages on basis of water-cement ratio.

WATERPROOFING. Waterproofing with Emulsified Asphalt, S. C. Hunter. *Maintenance Eng.*, vol. 89, no. 9, Sept. 1931, p. 432. Properties of high-grade emulsified asphalt of proper texture and consistency for waterproofing all types of

"Three years in the



READY FOR TRIAL: (above) An 'Incor' concrete core, drilled from the pavement to determine its ultimate strength. The beam and counterweight of the testing machine are seen in the background. The 3 'Incor' cores from the Chicago Loop developed an average compressive strength of 8567 pounds per square inch.

THE REASON: (right) This diagram illustrates the difference in chemical constitution between ordinary Portland Cement and 'Incor' Portland Cement. The complete circles symbolize molecules of *tri*-calcium silicate (3 atoms of lime to 1 atom of silica) which are active and combine easily and thoroughly with water. The incomplete circles symbolize molecules of *di*-calcium silicate (2 atoms of lime to 1 atom of silica) which are sluggish and combine with water slowly. This difference in refinement is achieved by double-burning.

Loop—and look at those figures!"

Core tests demonstrate why pavement laid in 1928 still looks new

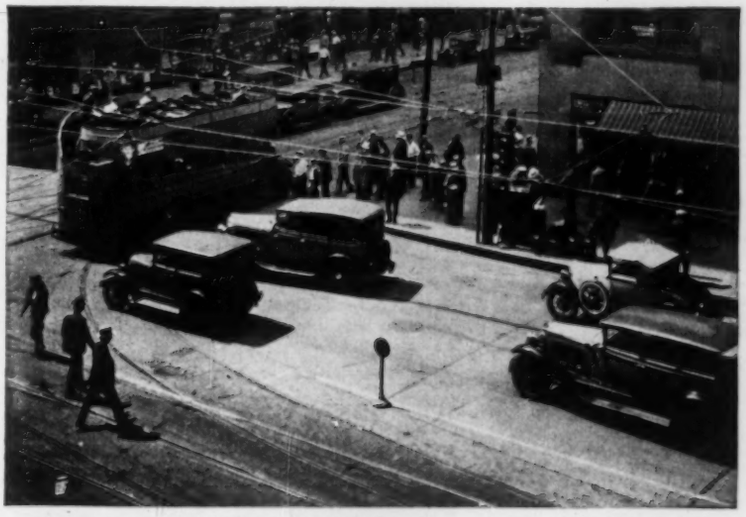
THREE cores stood beside the compression machine. They had just been drilled from the body of the pavement at the Washington and La Salle Street intersection in the Chicago Loop.

For almost three years this pavement had been pounded by Loop traffic at one of its busiest corners. 180,000 vehicles enter and leave the Loop daily.

The pavement from which the cores were drilled—*poured in October, 1928*—was still in almost perfect condition. Its unblemished surface had been the subject of special comment by interested observers.

The *surface* spoke for itself. These tests were to tell the rest of the story . . .

Officials and engineers stood by as pressure was applied on core No. 1. They glanced at each other as the pressure passed 175,000 pounds. This core gave an inkling of what was to follow.



THE CORNER IN THE LOOP. The Washington and North La Salle Street intersection of the Chicago Loop, where 'Incor' cement concrete was used in 1928. The 'Incor' surface is still in almost perfect condition, the reasons for which were determined by the core tests described below.

"186,000 POUNDS—8192 POUNDS PER SQUARE INCH."

The shattered fragments of the first core were cleared away, the second core was dusted, placed in position, and the screws began to turn . . .

"*No. 2.* 194,000 POUNDS—8510 POUNDS PER SQUARE INCH." The third followed.

"*No. 3.* 205,000 POUNDS—9000 POUNDS PER SQUARE INCH." A bystander whistled. "*Three years in the Loop, and look at those figures!—an average compressive strength of 8567 pounds per square inch.*"

* * *

Those cores were taken from the small section of 'Incor' cement concrete used in that important widening-and-repaving job carried out by the City of Chicago on North La Salle Street between Washington and West Lake Streets in October, 1928.

This paving job, carried on under the closest engineering supervision, was in the nature of a service test as to the suitability of concrete in any highly congested business district. A feature of this "test" was therefore the area at the Washington-La Salle intersection, which was paved with 'Incor',* *the then new high-early-strength cement.*

The weather was unseasonably cold. The protection given the concrete was not sufficient to enable high strengths at early periods to be realized. In fact, one-day strengths were not in the general picture at all, since 'Incor' was used on such a small part of the job. *But in spite of the weather, the 'Incor' section, which was placed on Saturday, was in service and carrying full traffic Monday morning, seven days before the adjoining sections of the pavement could be used.*

And the quantity of 'Incor' used had been precisely the same as that of ordinary Portland Cement in the adjoining pavement.

That demonstration of high early strength occurred on October 29, 1928.

The intervening years have served to produce the more telling proof—an *ultimate* strength hardly less remarkable.

*Reg. U. S. Pat. Off.

'INCOR' *24-Hour Cement*

MANUFACTURED BY THE "DOUBLE BURNING" PROCESS

'INCOR' Cement is made by the producers of Lone Star Cement, under basic patents owned by International Cement Corporation, New York City

surfaces; outline of operations for emulsified asphalt application to concrete.

CONSTRUCTION INDUSTRY

COSTS. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 107, no. 16, Oct. 15, 1931, pp. 634–635, 3 figs. Unit prices bid on construction of Thief Valley Dam in Oregon; dam is of buttressed type, with reinforced-concrete slabs; 380 ft. long and 66 ft. high; also prices bid on Sag Harbor and Greenport highway suspension bridges to Shelter Island, N. Y.; 700 and 1,100-ft. spans, respectively.

DAMS

EARTH-FILL, CALIFORNIA. Santiago Creek Earth-Fill Dam Near Orange, A. Kempkey. *West. Construction News*, vol. 6, no. 21, Nov. 10, 1931. pp. 576–581, 7 figs. Design of dam in Southern California, having maximum height of 160 ft., with freeboard of 20 ft.; dam has no core wall but is lined on upstream face with 6-in. reinforced concrete slab; construction set-up; geology and topography; stripping dam site.

RESERVOIRS, WHITE PLAINS, N. Y. A Reservoir with Unusual Features, S. K. Knox. *Water Works Eng.*, vol. 84, no. 21, Oct. 21, 1931, pp. 1483–1484, 1 fig. Construction of reinforced concrete covered distributing reservoir of White Plains, N. Y.; reservoir occupies area of approximately 204 by 260 ft. and has maximum depth of 32.5 ft.; adaptation of shape of reservoir to topography of ravine; main wall is designed as dam backed with rock-fill from excavation; cost $255,485.

ROCK-FILL, CHILE. Earthquake-Proof Dam in Chile. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, p. 725, 3 figs. Features of Cogoti concrete-paved rock-fill dam costing about $1,000,000; design is based on following principles: (1) building rock-fill that will not flatten further under shock; and (2) making it watertight by slope pavement that will flex without rupture.

WEIRS, APRONS. Percolation Under Masonry Aprons, S. Leliavsky. *Engineering*, vol. 132, no. 3432, Oct. 23, 1931, pp. 528–529. Review of pamphlet on percolation under aprons of irrigation works by chief of designing office of Egyptian Public Works Department.

FLOOD CONTROL

ALLUVIAL RIVERS. Flood Control on Alluvial Rivers—II, F. H. Tibbets. *Eng. News-Rec.*, vol. 107, no. 116, Oct. 15, 1931, pp. 606–609, 8 figs. Design and construction of flood-control structures on Sacramento River, with particular reference to levee sections, free-board, and protective covering; constructing hydraulic-fill levee 22 ft. high; clamshell-dredge construction of river levee; cost about 10¼ cents per cu. yd.; types of levees for Sacramento River flood control; retards; spillway types and structures.

RESERVOIRS. Reservoir Effect Upon River Floods, F. S. Besson. *Military Engr.*, vol. 23, no. 132, Nov.–Dec. 1931, pp. 577–580, 8 figs. Graphical and analytic study of effect of detention reservoirs on flood flows of Cumberland River, which is tributary of Ohio River.

SHORE PROTECTION, GREAT BRITAIN. Fleetwood's Sea Defence Works and Promenades, with Reference to Flood of October 1927, W. Melville. *Inst. Mun. and County Engrs.*, vol. 58, no. 9, Oct. 27, 1931, pp. 661–674 and (discussion) 675–677, 13 figs. Observations on coast erosion; construction of rock-fill shore-protection works; movement of beach shingle; destructive effects of unusually high tide of Oct. 29, 1927.

FLOW OF FLUIDS

AIR MEASUREMENT. Measurement of Air Flow—IX, F. Ower. *Instruments*, vol. 4, no. 10, Oct. 1931, pp. 533–540, 4 figs. Manometers; tilting micromanometer; Chattock manometer.

PIPES. Equivalent Carrying Capacities of Pipes, A. Alison. *Power Engr.*, vol. 26, no. 307, Oct. 1931, pp. 368–370, 1 fig. Carrying capacities of pipes not directly proportional to cross-sectional areas; graphical method of determination.

WIND TUNNELS, GREAT BRITAIN. New Wind Tunnels of Royal Aircraft Establishment, R. McK. Wood. *Engineering*, vol. 132, no. 3433, Oct. 1931, pp. 563–564, 10 figs., partly on supp. plates. Aerodynamic principles of design of wind tunnels; review of developments; types developed by National Physical Laboratory; large wind tunnel which it is proposed to erect at Farnborough.

FOUNDATIONS

CONSOLIDATION. Solidifying Gravel, Sand, and Weak Rock, L. R. Jorgensen. *West. Construction News*, vol. 6, no. 21, Nov. 10, 1931, pp. 591–593, 6 figs. Outline of Joosten process of consolidating loose formations, developed in Germany and described in several articles previously indexed in 1930 and 1931.

PILES, DESIGN. Reinforced Concrete Pile Formulae, D. V. Isaacs. *Inst. Engrs. Australia—Journal*, vol. 3, no. 9, Sept. 1931, pp. 305–323, 19 figs. Formulas for calculation of safe loads for reinforced concrete piles are critically examined, and errors in theory are shown; new theory of phenomena of driving is advanced; graphs for reinforced concrete pile driving; allowances are made for weight and drop of hammer, size and length of pile, size and weight of dolly or helmet, degree of cushioning in helmet, and type of supporting strata; longitudinal wave movements in piles.

SWAMPS, DRAINAGE. Well Points Drain Swamp Under Bridge Approach Structure. *Eng. News-Rec.*, vol. 107, no. 17, Oct. 22, 1931, pp. 665–666, 3 figs. Peat bog area, 65 by 600 ft., dried up and removed to provide foundations for street-car subway, crossing New Jersey approach to Hudson River Bridge, after piling proves unstable; muck offered little lateral stability to piles, and therefore their use was impossible; two header pipes were placed 65 ft. apart, extending for 600 ft. along outside lines of excavation; well points were driven to rock every 3 ft. along these header lines, each point being connected directly to header.

HYDRAULIC ENGINEERING

UNITED STATES. New Hydraulic Laboratory at University of Tennessee. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, pp. 724–725, 2 figs. Description of instruction and of research laboratories with about 6,200 sq. ft. of floor space, having a canal 6 ft. wide, 6 ft. deep, and 76 ft. long, equipped with a centrifugal pump designed to discharge 5,000 gal. per min. against a head of 22 ft., or 2,000 gal. against a head of 36 ft.; surge tank is 5 ft. in diameter and 22 ft. high.

HYDRO-ELECTRIC POWER PLANTS

IRRIGATION. Hydro Power Provides Revenue for Irrigation Works, H. A. Brown. *Power*, vol. 74, no. 19, Nov. 10, 1931, pp. 663–665, 3 figs. By combining power development with irrigation dams it is possible to pay construction costs of projects from power sales; under new policy, power profits are first applied to repaying power plant's cost, then dam and reservoir cost, and after that they are credited to reclamation fund; power plants operated on Bureau of Reclamation projects during fiscal year.

ONTARIO. Power Plant in Northern Ontario Largely Built During Winter Months, D. Hutchison and R. F. Legget. *Eng. News-Rec.*, vol. 107, no. 18, Oct. 29, 1931. pp. 678–682, 10 figs. Construction of Upper Notch Dam and 13,000-hp. power plant of Northern Ontario Power Co.; cold-weather operations speeded up by wide use of mechanical equipment; channel operations carried on during period of low river flow in midwinter; power house is integral part of gravity dam, 500 ft. long and 70 ft. high; arrangement of cofferdams and by-pass channel; layout of crushing and concrete plant; remote-control for crest gates.

WASHINGTON. Ariel Hydro-electric Project, Washington, *Western Construction News*, vol. 6, no. 19, Oct. 10, 1931, pp. 525–530, 15 figs. Construction of Inland Power and Light Co. development on Lewis River; initial cost of $9,000,000 for 45,000-kw. capacity; ultimate cost $12,000,000 for 180,000-kw. capacity; preliminary investigations; construction schedule; river diversion tunnel, 1,467 ft. long; dam has single arch of variable radius 313 ft. above bedrock, with gravity section at each end; total length 1,342 ft.; foundation excavation; grouting; placing concrete; handling construction materials.

INDUSTRIAL BUILDING

AIRSHIP PLANT, AKRON, OHIO. Goodyear Zeppelin Airship Dock, W. J. Watson. *Military Engr.*, vol. 23, no. 132, Nov.–Dec. 1931, pp. 539–543, 3 figs. Design and construction of Akron dock measuring 1,175 ft. between center lines of door tracks; width 325 ft.; height 197½ ft.; experimental studies of wind pressures; effect of temperature changes; operating mechanism for doors; control of temperatures; handling and storage of helium.

GRAIN ELEVATORS, CANADA. Highway and Track Work at Prescott, E. Smith. *Can. Engr.*, vol. 61, no. 1, Nov. 10, 1931, pp. 7–10, 6 figs. Supplementary construction work in connection with grain elevator, including dredging of slips.

INLAND WATERWAYS

CANAL, WELLAND. New Welland Ship Canal, A. B. Jones. *Military Engr.*, vol. 23, no. 132, Nov.–Dec., 1931, pp. 527–531, 6 figs. General non-technical description; history of Welland Canal; new ship canal; design and construction; related channels and harbors.

RIVER IMPROVEMENTS. Missouri River Abatis, F. Y. Parker. *Military Engr.*, vol. 23, no. 132, Nov.–Dec., 1931, pp. 535–536, 4 figs. Description of successful silt-catching device made of wood poles or wire.

IRRIGATION

GREECE. Reclaiming Macedonia's Plains, W. P. Christie. *Constructor*, vol. 13, no. 10, Oct. 1931, pp. 24–26, 6 figs. Outline of Greek government's $23,000,000 drainage, flood control, and irrigation project under way in Macedonia; features of American and European excavating and earth-handling equipment.

INDIA. Indigenous Irrigation Works in Peninsular India, A. V. Williamson. *Geographical Rev.*, vol. 21, no. 4, Oct. 1931, pp. 613–626, 7 figs. Irrigation by tanks; advantages and disadvantages of tanks; areal distribution of tanks; embanking as means of soil and water conservation; well irrigation; areal distribution of wells; crops watered from wells; desirability of increasing number of wells.

MATERIALS TESTING

BUILDING MATERIALS. Modern Research on the Nature of Materials of Construction (steel and concrete), H. Jackson. *Structural Engr.*, vol. 9, no. 10, Oct. 1931, pp. 341–350, 19 figs. Summary of twentieth century research on fundamental properties of steels, iron alloys, and concrete, including results of spectrographic analysis.

CONCRETE. Temperature Rise of Concrete, N. Davey. *Concrete and Constr. Eng.*, vol. 26, no. 10, Oct. 1931, pp. 572–575, 4 figs. Method of determining, from small sample of concrete, maximum temperature rise likely to occur in larger mass of same material; description of apparatus in which temperature rise of samples tested is gaged by means of thermocouples, galvanometer, and thermionic valves.

PLASTICITY. Phenomenon of Slip in Plastic Materials, A. Nadai. *Am. Soc. Testing Mails.—Reprint*, vol. 31, pt. 2, 1931, 36 pp., 40 figs. Models of various states of matter; surfaces of slip; ideal loose material; Schlieren method for observing flow layers in plastic materials; flow layers produced under various states of stress; slip lines in plane fields of stress in plastic materials; surfaces of slip in geology; use of new optical bench designed by author for study of formation of plastic slip layers in test specimens.

WELD STRESSES. Maximum Stress: Its Influence on Cost and Service Life of a Structure, E. Chapman. *Am. Welding Soc.—Journal*, vol. 10, no. 9 Sept. 1931, pp. 19–22, 7 figs. Photoelastic methods illustrate stress distribution with particular regard to causes of stress concentration; undercut fillet weld subjected to tension; undercut butt weld subjected to tension; unscarfed double fillet weld subjected to tension.

PORTS AND MARITIME STRUCTURES

CONSTRUCTION. Recent Dock and Harbor Improvements, M. Du Plat-Taylor. *Civil Eng. (Lond.)*, vol. 26, no. 304, Oct. 1931, pp. 21–24, 7 figs. Description of improvements and dock extensions at Port of Southampton, being carried out on behalf of Southern Railway; sinking of 37 monoliths; improvements of other ports in Europe.

STEAM-ELECTRIC POWER PLANTS. Clarence Dock Power Station of Liverpool Corporation. *Engineering*, vol. 132, no. 3433, Oct. 30, 1931, pp. 544–546, 5 figs. Each transformer is rated at 35,700 kva., secondary pressure being 33 kv.; manufactured by Metropolitan-Vickers Electrical Co.; results of tests. (Continuation of serial.)

RAILROADS, STATIONS, AND TERMINALS

RAILROAD STATIONS, ST. JOHN, NEW BRUNSWICK. Union Station for St. John, New Brunswick. *Can. Ry. and Mar. World*, no. 404, Oct. 1931, pp. 621–623, 2 figs. Layout and construction features of new union station for joint use by Canadian National and Canadian Pacific Railways.

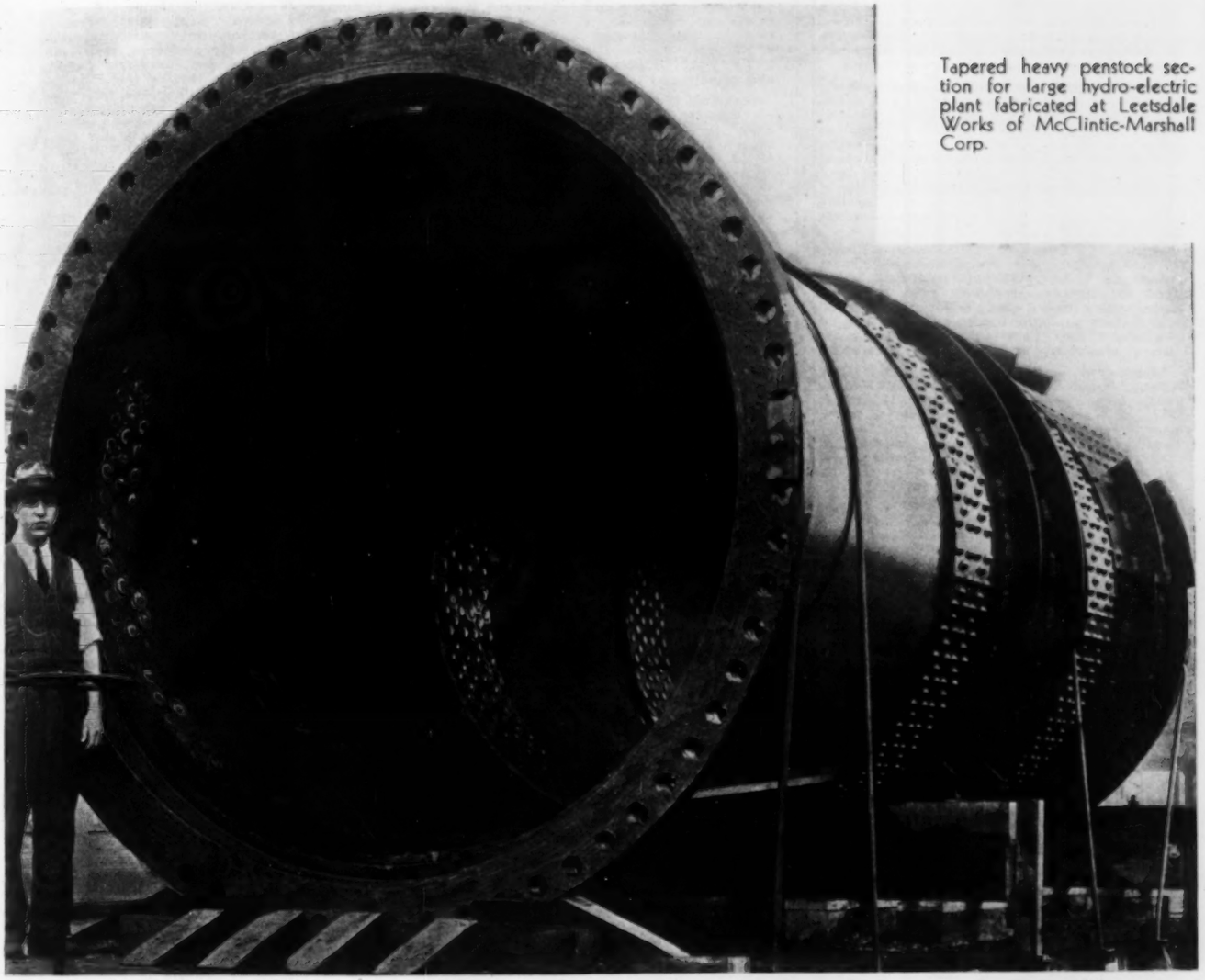
ROADS AND STREETS

BITUMINOUS. Modern Roads to Meet Modern Traffic, G. O. Warren. *Can. Engr.*, vol. 61, no. 19, Nov. 10, 1931, pp. 15–16. Asphalt penetration construction; development of penolithic pavement; warcolite cold-lay mix. Before U.S. Good Roads Ass'n Congress.

CANADA. Trend of Practice in Concrete Paving, M. A. Lyons. *Can. Engr.*, vol. 61, no. 15, Oct. 13, 1931, pp. 11–17 and 49–50. Major changes in concrete design and manufacture; details of concrete road design and construction; proportioning theories and methods; bulk cement; mixing on road work; concrete proportioning equipment; concrete curing methods; testing concrete pavements; finishing methods and specifications; joint practice; concrete paving completed in Canada; width of pavement; thickened pavement edges; lip curb; steel forms; subgrade preparation and sub-soils; shoulder and bridge widths. Before Can. Good Roads Ass'n.

CONCRETE, CONSTRUCTION. Paving Seven Miles in Seven Weeks. *Contractors and Engrs. Monthly*, vol. 23, no. 4, Oct. 1931, pp. 43–46, 9 figs. Description of methods used in construction of concrete highway near Everly, Iowa; contractor used single paver and poured 100 ft. per hour on average for entire job; dock for handling bulk cement; grading ahead of form setting.

CONSTRUCTION, CALIFORNIA. Western Highway Practice, with Special Reference to California, C. S. Pope. *Am. Soc. Civil Engrs.—Proc.*,



Tapered heavy penstock section for large hydro-electric plant fabricated at Leetsdale Works of McClintic-Marshall Corp.

STEEL PLATE CONSTRUCTION

Long experience and modern fully-equipped plants enable McClintic-Marshall to handle promptly and efficiently the design, fabrication and erection of all types of steel plate construction.

McClintic-Marshall Steel Stand Pipes, Stacks, Surge Tanks, Oil Tanks, Gas Holders and High-Pressure Cylinders as well as similar products made of steel plate are fabricated and erected by a skilled force of steel plate specialists who have set a standard of workmanship that is unsurpassed.

McCLINTIC-MARSHALL CORPORATION
Subsidiary of Bethlehem Steel Corporation
General Offices: Bethlehem, Pa.

District Offices in New York, Boston, Philadelphia, Baltimore, Pittsburg, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, San Francisco, Los Angeles
Export Distributor: Bethlehem Steel Export Corporation, New York City

McClintic-Marshall

Our Hay Works at Newark, N. J., is advantageously located to execute promptly orders for light steel plate work in the Metropolitan area. Quick delivery of fabricated parts to the erection site is but one of the many economies afforded by this favorably located plant.

vol. 57, no. 9, Nov. 1931, pp. 1319–1341, 14 figs. Outline of methods designed to insure protection against stream erosion and floods, cloudbursts, and destructive action of sea; highway financing; clearing right-of way previous to construction.

DESIGN. Design of the Reinforced Concrete Road Slab, L. E. Grinter. *Agric. and Mech. College Texas—Bul.*, vol. 1, no. 3, Mar. 1, 1931, 88 pp., 19 figs. Method of design for new type of concrete road slab, use of reinforcing steel in both top and bottom surfaces; probable costs of reinforced and plain concrete slabs; analysis of stresses in reinforced concrete road slab; action of doweled joints; economic considerations regarding use of joints; construction of reinforced concrete road slab.

LOW-COST. Low-Cost Bituminous Roads, W. N. Frickstad. *Am. Soc. Civil Engrs.—Proc.*, vol. 57, no. 9, Nov. 1931, pp. 1343–1353, 2 figs. Need for low-cost secondary road that will accommodate limited heavy traffic and unlimited light traffic; asphaltic binder known as fuel oil successfully used to treat crushed aggregate; surface treatment and oil-mixing treatment.

MACHINERY, SPREADERS. Fantail Chip Spreader Speeds Surface Treatment, J. R. McDermott. *Eng. News-Rec.*, vol. 107, no. 15, Oct. 8, 1931, pp. 572–573, 3 figs. Description of home-made spreader, costing $37, built of 2½ by 8½-ft. plate, 78 ft. of small angles, and 12 ft. of chain; two spreaders and six 3-ton trucks handle 300 tons a day.

PAVEMENT, MAINTENANCE AND REPAIR. Methods and Charges for Repairing Pavement Cuts. *Roads and Streets*, vol. 71, no. 10, Oct. 1931, pp. 412–413. Information on methods and charges for repairing cuts on paved streets in cities of third class in Pennsylvania.

RHODE ISLAND. Field Observations of Highway Practices—Bituminous Macadam Highways in Rhode Island, C. S. Hill. *Eng. News-Rec.*, vol. 107, no. 18, Oct. 29, 1931, pp. 692–694, 6 figs. Foundation design, construction materials, and methods; foundations are crucial consideration; pavement construction; construction procedure is strictly controlled.

ROAD DESIGN. Widening and Constructing Highways, C. E. Burleson. *Can. Engr.*, vol. 61, no. 17, Oct. 27, 1931, pp. 16 and 61. Recommendations from report of American Road Builders' Ass'n Committee on design and construction. Before Am. Good Roads Ass'n.

SINGLE-TRACK. Single-Track Concrete Highways. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 1931, pp. 726–729, 6 figs. Symposium of two articles: Cost and Serviceability, E. M. Fleming; Upkeep Cost in Illinois, M. D. Catton; survey of place of single-track concrete pavement in local road improvement, with records of maintenance costs, by engineers of Portland Cement Association.

SANITARY ENGINEERING

MASSACHUSETTS. Heavy Construction Program Follows Formation of South Essex Sanitary District, B. F. Snow. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, pp. 731–735, 5 figs. Creation of modern type of regional organization enables towns in Massachusetts to effect noteworthy remedial measures eliminating watercourse pollutions; laying sewer siphons; pipe alignment by divers; trade waste treatment; split venturi tubes; deposition of carbonates and organic matter in pipes and in pumps.

SEWERAGE AND SEWAGE DISPOSAL

CITIES. Municipal Sewage Disposal Principles. *Can. Engr.*, vol. 61, no. 20, Nov. 17, 1931, pp. 17–18 and 47–48. Treatment of industrial wastes; sewage treatment versus purification; screening and sedimentation; decomposition, liquefaction, and gasification; final treatment; irrigation, filtration, and oxidation; operation of trickling filters; ultimate disposal. Prepared in cooperation with Department of Biology and Public Health, Mass. Inst. Tech.

DEARBORN, MICH. Novel Sewage Treatment Process Developed for Dearborn, Mich., M. B. Owen. *Water Works and Sewerage*, vol. 78, no. 10, Oct. 1931, pp. 279–283, 4 figs. Description of experimental plant and new West Side plant, costing about $8,000,000, equipped with traveling screens and magnetite filters; raw sewage is mixed with lime, ferric chloride, and paper; comparison of results with Imhoff tanks and experimental tanks; flow sheets of Dearborn sewage disposal; sludge handling and disposal.

DESIGN. The Round Table. *Mun. Sanitation*, vol. 2, no. 11, Nov. 1931, pp. 549–551. Practical discussion of advantages or disadvantages of having sewers under sidewalks rather than beneath street.

CANTON, OHIO. Canton, Ohio, Uses Liquid Sludge on City Farm, C. C. Hommon. *Pub. Works*, vol. 62 no. 11, Nov. 1931, pp. 28 and 69–70. Paper before Carolina Sewage Works Ass'n, previously indexed from various sources.

LOS ANGELES, CALIF. Storm Water Crossing Over Outfall Sewer, R. I. Reinhardt. *West City*, vol 7, no. 10, Oct 1931, p. 18, 1 fig. Los Angeles installation involves 40-ft. drop in approximately 162 ft.; guard against erosion.

PLANNING. Rules and Regulations for Preparation and Submission of Plans for Systems of Sewerage and Sewage and Waste Disposal. *N.Y. Dept. Health—Division Sanitation*, 1931, 31 pp., 1 fig. Report on municipal, institutional, and private and industrial systems.

SLUDGE. Sludge Temperatures and Capacities of Digestive Tanks, E. W. Steel and P. J. A. Zeller. *Agric. and Mech. College Texas—Bul.*, no. 40, Dec. 1, 1931, pp. 3–12 and (discussion) 12–13, 2 figs. Daily readings of atmospheric, sewage, and sludge temperatures at separate sludge digestion tank and Imhoff tank; computations for sludge capacity; relation between sludge temperature and time required for digestion of seeded sludge.

SURVEYING

AERIAL. How Aerial Photographic Mapping Is Affected by Weather, E. H. Corlett. *Eng. News-Rec.*, vol. 107, no. 20, Nov. 12, 1931, p. 766. Engineering manager, Fairchild Aerial Surveys, Inc., New York City, discusses conditions for best work and influence of departures therefrom; contract conditions.

HYDROGRAPHIC. Graphic Pressure Sounder, H. E. Libby. *Military Engr.*, vol. 23, no. 131, Sept.–Oct. 1931, pp. 456–457, 4 figs. Description of bathometer consisting of sounding lead, recording instrument, and air pump; weight of sounding chamber is 29 lb.

TRIANGULATION. Simplified Adjustment of a Quadrilateral, W. D. Myers. *Eng. News-Rec.*, vol. 107, no. 18, Oct. 29, 1931, p. 703, 2 figs. Outline of method developed by Pennsylvania Water and Power Co. for triangulation by use of quadrilaterals, rather than of series of adjacent triangles; adjustment of errors of observation is reduced to comparatively simple problem requiring considerably less labor than usual method involving use of logarithms.

TRAFFIC CONTROL

BRIDGES, SUSPENSION, HUDSON RIVER. Complex Approaches Developed to Promote Efficient Use of Hudson River Bridge. *Eng. News-Rec.*, vol. 107, no. 17, Oct. 22, 1931, pp. 657–664, 11 figs. Layout of New York approach, providing connections to main north and south traffic arteries with no grade crossings and separated "onbound" and "offbound" traffic, includes two ventilated tunnels several blocks long; similar facilities for west end of bridge; concrete arch carrying main ramp over Riverside Drive designed to carry unusual load of 235,000 lb. per ft.; typical section of ventilated tunnels; in New Jersey approach consists of concrete-incased steel girders on three-column reinforced-concrete bents.

HIGHWAY, LOS ANGELES, CALIF. Ironing Out the Traffic Wrinkles on Wilshire Boulevard in Los Angeles, W. R. Lindersmith. *West. City*, vol. 7, no. 2, Nov. 1931, pp. 7–8, 1 fig. Twenty-three intersections controlled by new $82,000 synchronized light signals; it is now possible to drive entire five miles without stopping.

STREET RAILROADS. Costs and Competition in Street Use, E. J. McIlraith. *Elec. Ry. Journal*, vol. 75, no. 11, Oct. 1931, p. 571. Elementary details of study conducted by committee on street traffic economics of past history of automobile as affecting mass transportation agencies; analysis of future growth; traffic control will give ample street space.

TUNNELS

GREAT BRITAIN. Cementation in the Severn Tunnel, G. W. R., R. Carpmael. *Ry. Engr.*, vol. 52, no. 620, Sept. 1931, pp. 329–332, 4 figs. Account of strengthening work by cement grouting through lining; sectional elevation of Severn tunnel.

PEDESTRIANS. Tunnel for Saddle-Horse Use on New Glacier Park Trail, G. W. Reed. *Eng. News-Rec.*, vol. 107, no. 19, Nov. 5, 1931, p. 730, 2 figs. Construction of tunnel 183 ft. long for saddle horses and hikers to shorten distance from Many Glacier Hotel to Waterton Lake in Glacier National Park; tunnel piercing solid rock ridge, known as Ptarmigan Wall, is 6 ft. wide and 9 ft. high and has arched roof.

RAILROAD CONSTRUCTION. Canadian Pacific Railway Company's Wolfe's Cove Branch and Tunnel at Quebec, D. Hillman. *Eng. Journal*, vol. 14, no. 11, Nov. 1931, pp. 549–554, 9 figs. Equipment and method used for driving, lining, drainage, and ventilation during construction; tunnel length 5,340 ft.; clear width inside 16 ft. and clear height above base of rail 22 ft. 6 in.

WATER PIPE LINES

CAST IRON. Special Lining of Pipe Insures Retention of Carrying Capacity of Cast-Iron Mains, A. Potter. *Water Works Eng.*, vol. 84, no. 22, Nov. 4, 1931, pp. 1545–1546 and 1567, 1 fig. Installation of complete distribution system, with 25 miles of from 6 to 12-in. cast iron mains, which was lined, for Parsippany-Troy Hills Township, New Jersey, under supervision of the writer; centrifugal application of bituminous lining; sodium carbonate difficulties.

PROTECTIVE COATINGS. Why Not Call for Quotations on Pipe Line Protection? K. H. Logan. *West Gas*, vol. 7, no. 10, Oct. 1931, pp. 37–38 and 64. Suggestion is advanced that pipe-line operators buy guaranteed protection rather than merely protective materials; purchaser would receive something definite and could predetermine whether such purchase was economical; responsibility for performance of coating would rest with one organization, and this would result in greater care in selecting and applying materials and in lower cost of pipe-line protection.

RIVER CROSSINGS. Cast-Iron Pipe River Crossing Installed Without Special Equipment. *Eng. News-Rec.*, vol. 107, no. 18, Oct. 29, 1931, p. 702, 1 fig. Methods of laying 10-in., class C cast-iron pipe across stream 610 ft. wide at a maximum depth of 30 ft.; crossing was installed by five men in three working days using equipment available in water company shops, at Endicott, N.Y.

WATER PUMPING PLANTS

CENTRIFUGAL. Centrifugal Pump Performance Characteristics, D. G. McNair. *Power Engr.*, vol. 26, no. 307, Oct. 1931, pp. 385–387, 3 figs. Economics of pumping; centrifugal pump characteristics; self-regulation; auto-regulation adjusted to duty point; characteristic curves with auto-regulator.

FIRE PROTECTION. Milwaukee Installs High Pressure Station for Fire Protection, H. H. Brown. *Water Works Eng.*, vol. 84, no. 22, Nov. 4, 1931, pp. 1539–1540, 3 figs. Description of new unit which will form nucleus of system for guarding high value districts of city; pumping station consists of 2-story pump room containing three 2,500 g.p.m. motor-driven centrifugal pumps; method of priming main pumps; starting equipment.

WATER TREATMENT

CARBON. Use of Charcoal and Activated Carbon in Water Treatment—I, J. R. Baylis. *Water Works and Sewerage*, vol. 78, no. 10, Oct. 1931, pp. 287–290. Review of patents and uses of charcoal and animal charcoal for water filters; places in United States and Canada where charcoal filters have been constructed since 1852. Bibliography.

Use of Charcoal and Activated Carbon in Water Treatment—II, J. R. Baylis. *Water Works and Sewerage*, vol. 78, no. 11, Nov. 1931, pp. 320–324, 2 figs. Characteristics of activated carbon: apparent density, granule density, true density, porosity, activity; composition of materials used for making activated carbon; loss in density and weight, increase in adsorption, and changes in pore volume charcoal upon activation. Bibliography. (To be continued.)

COAGULATION. Alum and Aluminates in Water Treatment, G. J. Fink. *Chem. and Met. Eng.*, vol. 38, no. 9, Sept. 1931, pp. 535–536, 2 figs. Alum is found useful in treatment of raw water for purpose of coagulation, and sodium aluminate is used as combined coagulant and softening agent.

FILTRATION PLANTS. Filter Plant Operators' Experiences, I. M. Glace. *Can. Engr.*, vol. 61, no. 18, Nov. 3, 1931, pp. 13–34 and 47–48. Review of experiences with design features at variance with those generally accepted; coagulation; prevention of mud balls; loss of head gage; test for excess chlorine; aqua-ammonia treatment. Before Maryland-Delaware Water and Sewerage Ass'n.

OPERATION. Trends in Water-works Operation, A. P. Learned. *Can. Engr.*, vol. 61, no. 18, Nov. 3, 1931, pp. 17–18. Recent improvements in purification of water and pumping equipment; water distribution systems; flexibility of water treatment; taste and odor removal; size of filter sands. Before Montana Section, Am. Water Works Ass'n.

RESERVOIR, ALGAE CONTROL. Chlorine Control of Certain Algae Growth in Los Angeles Reservoir, C. Wilson. *West City*, vol. 7, no. 10, Oct. 1931, pp. 25–28, 5 figs. Barge equipped with chlorinators destroying protococcus without producing unpleasant odor or taste; experiment with chlorine; superchlorination possibilities; chlorinating barge assembly.

WATER WORKS ENGINEERING

COLORADO. Water Works for Boulder City, Nevada, B. Lowther. *West Construction News*, vol. 6, no. 20, Oct. 25, 1931, pp. 547–550, 7 figs. Description of water works, deriving its supply by centrifugal pumping from Colorado River, one mile below site of Hoover Dam, to serve population of 5,000; details of water treatment plant equipped for aeration, water softening, clarification, carbonation, rapid-sand filtration, and chlorination.

EMERGENCY SUPPLIES. Emergency Water Supply of 4 m. g. d. Completed in 70 Days, A. D. Couch. *Eng. News-Rec.*, vol. 107, no. 20, Nov. 12, 1931, pp. 758–761, 4 figs. Lexington, Ky. forced by drought to construct 7 miles of 20-in. cement-lined, cast-iron pipe to Kentucky River; new power line, and two pumping stations; wooden frame and chain-fall were used to handle pipe.